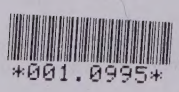
USER'S HANDBOOK

1081

datron

INSTRUMENTS

digital multimeter



USER'S HANDBOOK

for

THE DATRON AUTOCAL 1081 DIGITAL MULTIMETER

(for maintenance procedures
refer to the Calibration and Servicing Handbook)

850042 Issue 2 (February 1984)

For any assistance contact your nearest Datron Sales and Service Center.
Addresses can be found at the back of this handbook.

Due to our policy of continually updating our products, this handbook may contain minor differences in specification, components and circuit design to the instrument actually supplied. Amendment sheets precisely matched to your instrument serial number are available on request.

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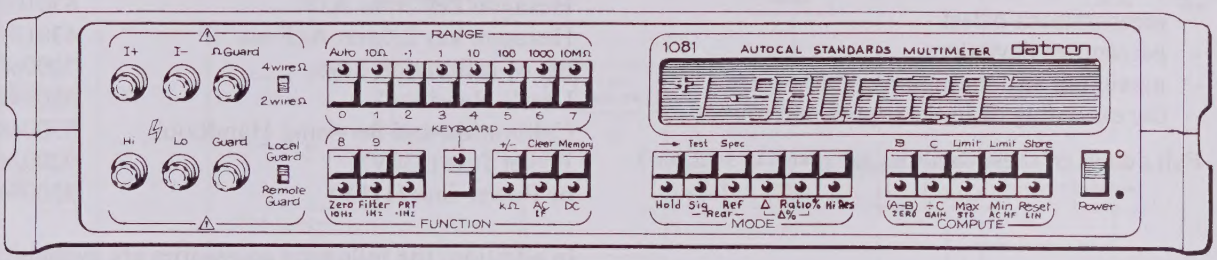
SECTION 1 THE 1081 AUTOCAL STANDARDS MULTIMETER



The Datron 1081 6½/7½ digit AUTOCAL STANDARDS microprocessor-controlled digital Multimeter (DMM) is a high precision measuring instrument. It features exceptionally high stability and systems capability. The instrument provides full measurement capability, computation facilities, self check routines and calibration memory.

Standard and optional measurement facilities

The instrument is offered in two versions, either complete with all options or as a basic DC voltage instrument to which individual options can be added to provide further measurements:

Resistance (including temperature)
True RMS AC voltage
DC coupled true RMS AC voltage
Ratio %, Δ, Δ%

The full range of options is as follows:

Option 10: True RMS AC Converter
Option 20: 4-Wire Resistance Converter
Option 40: Selectable Rear/Reference Input
Option 50: IEEE 488-1978 Standard Digital Interface
Option 52: Remote Trigger
Option 70: Analog Output
Option 80: 115V 60Hz Line Operation
Option 81: 115V 50Hz Line Operation
Option 82: 115V 400Hz Line Operation
Option 90: Rack Mounting Kit

Calibration

The AUTOCAL instruments have been designed to make the removal of the covers for calibration unnecessary, as full calibration of all ranges and functions can be carried out from the front panel.

The procedure for calibrating the instrument is contained in the Calibration and Servicing Handbook.

Accidental or unauthorised use of the calibration routine is prevented by a key operated switch on the instrument rear panel.

Message read-out

The measurement display doubles as a message display, providing a clear read-out of 14 different messages. Full details of the meanings of these displays can be found in sections 2 and 3.

Self test

Pressing the '→' then 'Test' key starts a self test procedure, during which a sequential routine:

- checks, in turn, all the display segments, characters and legends
- verifies the correct functioning of individual measuring circuits
- checks the non-volatile calibration memory

On completion of the test, the instrument returns to the last selected function and range to provide rapid return to measurement. In the event of the self test failing, an error message is displayed.

Computing

The range and function selection keys double as a keyboard for the input of data so that measurements can be compared with previously recorded data or manually input data for display of:

- measurement offset
- percentage deviation
- maximum and minimum value storage
- the exceeding of limits (upper and lower)

Full details of these facilities are given in section 3.

Systems use

The AUTOCAL 1081 instrument can form part of a system by means of the IEEE 488 standard digital interface option. The details for the connections of the instrument to the system and programming details for the controlling machine can be found in section 4.

Accessories

The instrument is supplied with the following accessories:

Description	Part Number
Power cable	920012
Hexagon key 2mm A/F	630101
Hexagon key 2.5mm A/F	630109
Set of calibration keys	700068
User's Handbook	850042
Calibration and Servicing Handbook	850048
Power fuse (230V)	920024
or Power fuse (115V)	920084

In addition, the following accessories are available for use with the 1081 instrument:

Description	Part Number
HVP high voltage probe	400335
RMK rack mounting kit (option 90)	440063
1501 de luxe lead kit	440070
PRT 100: Platinum resistance thermometer probe (100Ω)	630161

Additional documentation

The Calibration and Servicing Handbook contains information required to adjust and service the DMM. It contains detailed description of the circuits, trouble shooting diagrams, calibration procedures, parts lists and circuit diagrams.

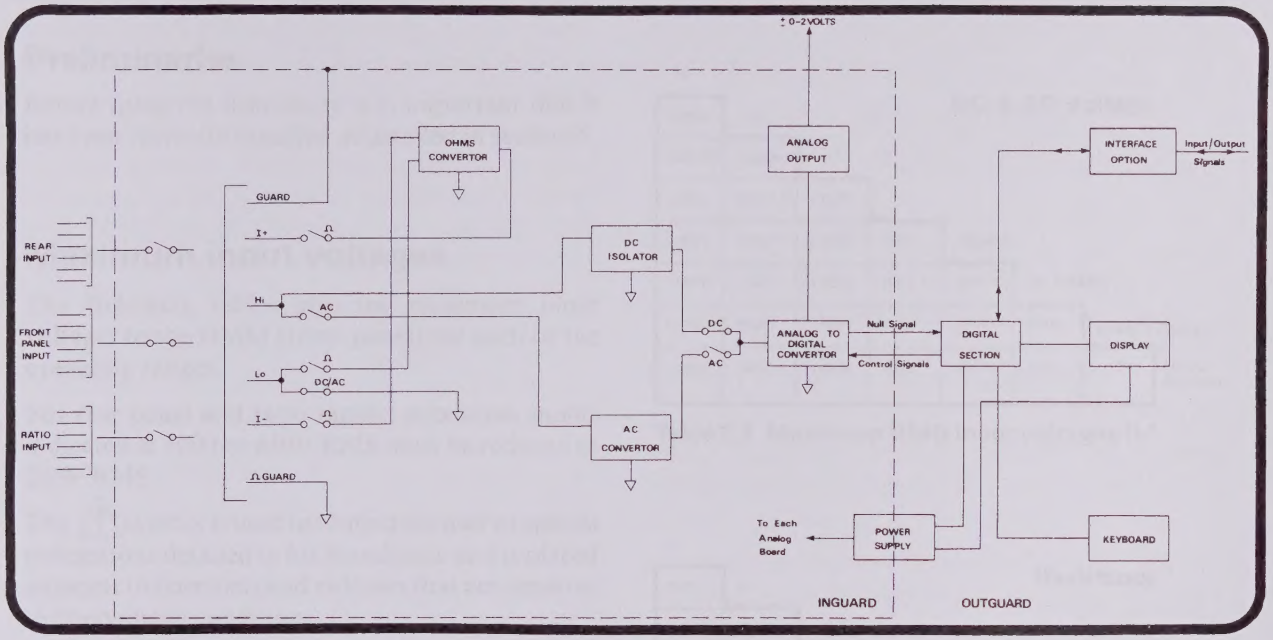


Fig. 1.1 DMM simplified block diagram

Figure 1.1 shows how the DMM achieves its basic measurement functions, its advanced measurement and computing functions and the interfacing with other equipment in systems applications.

Voltage measurement

The instrument comprises a fully floating isolation amplifier with electronically switched gain ranges providing a full range output which is applied to the analog to digital converter. AC voltage measurement is achieved using a True RMS AC converter which converts AC signals to DC and applies the DC voltage to the analog-to-digital converter.

Resistance measurement

Resistance measurement is achieved by passing the current from an internal precision current source through the unknown resistance and sensing the voltage developed across the resistance.

Temperature measurement

Temperature measurement is achieved by passing current from an internal precision current source through a platinum resistance thermometer (PRT) probe and sensing the voltage developed across the probe. This is converted digitally and then displayed in °C (PRT), or Ω (kΩ PRT).

Analog to digital conversion

The signal from the DC isolator or AC converter is applied to the input of a high gain integration amplifier. The integration capacitor starts charging from a zero state at a rate proportional to the magnitude of the incoming signal. The integration period is approximately 160mS.

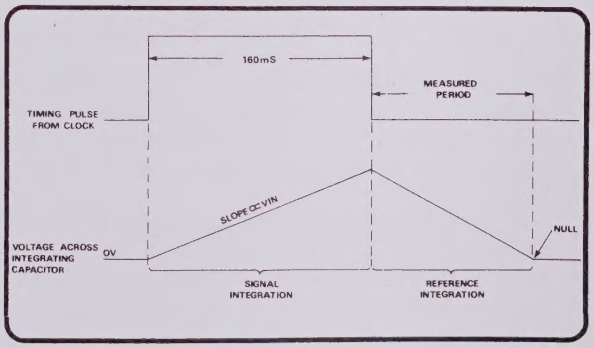


Fig. 1.2 Simplified measurement cycle

At the end of this period, a reference signal of opposite polarity to the input signal is applied and the time taken for the capacitor to discharge to zero volts is measured (null detection), providing an accurate computation of the input signal magnitude.

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SECTION 2 BASIC MEASUREMENT PROCEDURES

Preliminaries

Before using the instrument it is important that it has been correctly installed as detailed in section 5.

Maximum input voltages

The following tables give the maximum input voltages to the DMM (front panel) for each of the operating ranges.

For rear panel and ratio inputs, maximum inputs indicated at 1000 or 650V RMS must be reduced to 250V RMS.

The ⚠ symbol is used to remind the user of special precautions detailed in his Handbook and is placed adjacent to terminals and switches that are sensitive to overvoltage conditions.

DC & AC Voltage

Hi	Lo	I+	I−	GUARD	Ω's GUARD	SAFETY GROUND	LOGIC GROUND
1,000V							
250V [d]	1,000V						
1,000V	250V [d]	1,000V					
1,000V	250V [a]	1,000V	250V				
1,000V	0V	1,000V	250V	250V [a]			
1,000V	650V	1,000V	650V	650V [e]	650V		
1,000V	650V	1,000V	650V	650V [e]	650V	0V	

Table 2.1 Maximum RMS input voltages [b]

Resistance

Hi	Lo	I+	I−	GUARD	Ω's GUARD	SAFETY GROUND	LOGIC GROUND
250V							
250V [d]	250V						
250V	250V [d]	250V					
250V	250V	250V	250V				
250V	250V	250V	250V	250V [a]			
1,000V	650V	1,000V	650V	650V [e]	650V		
1,000V	650V	1,000V	650V	650V [e]	650V	0V	

Table 2.2 Maximum RMS input voltages [b]

NOTES:

a) With the local guard/remote guard switch set to 'Local Guard', this value reduces to 0V, i.e. the terminals are internally linked.

b) Values specified assume peak voltage $\leq$ RMS voltage x $\sqrt{2}$. Also, maximum inputs of 1000 or 650V RMS reduce to 250V RMS for rear and ratio inputs.

Maximum permissible voltage between front and rear inputs is equal to the maximum input at the front input (not switched) or 250V RMS (switched).

c) Logic Grounds for remote interfaces are internally connected to Safety Ground.

d) When the 2-wire Ω /4-wire Ω switch is set to '2-wire Ω', the 'I+' terminal is internally linked to the 'Hi' terminal and the 'I−' terminal is internally linked to the 'Lo' terminal.

e) Maximum slew-rate of 'Guard' with respect to Safety Ground or Logic Ground $\leq$ 50V/uS (5×10^2 volt Hz) for normal operation (accuracy is degraded as volt Hz product increases).

f) Maximum slew-rate of any terminal to Safety Ground should be $\leq$ 1kV/uS (10^6 volt Hz) or the instrument may revert to the 'power up' condition (i.e. select DC 1000V range).

Safety

The 1081 Multimeter is designed to be Class 1 equipment as defined in IEC Publication 348 and UL 1244 concerning safety requirements. Protection is assured by a direct connection via the power cable from ground to exposed metal parts and internal ground screens.

The line connection must only be inserted in a socket outlet provided with a protective ground contact and continuity of the ground conductor must be assured between the socket and the instrument.

WARNING:

ANY INTERRUPTION OF THE PROTECTIVE GROUND CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT OR DISCONNECTION OF THE PROTECTIVE GROUND TERMINAL MAY MAKE THE APPARATUS DANGEROUS. INTENTIONAL INTERRUPTION IS PROHIBITED.

THE TERMINALS MARKED WITH THE ϟ SYMBOL CARRY THE POTENTIAL OF THE SOURCE UNDER TEST. THESE TERMINALS AND ANY OTHER CONNECTIONS TO THE SOURCE COULD CARRY LETHAL VOLTAGES. AT NO TIME SHOULD THESE CONDUCTORS BE TOUCHED DURING A TEST OF HIGH VOLTAGES. IF DIFFICULTY IS FOUND WITH THE TEST, ENSURE THAT THE SOURCE IS RENDERED SAFE BEFORE ATTEMPTING TO IMPROVE CONNECTIONS.

Controls

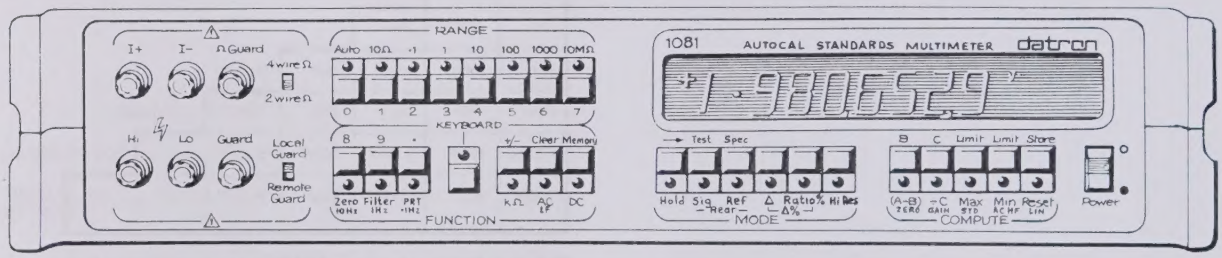


Fig. 2.1 Front panel

Line on/off ('Power') switch

When set to the **Off** position, this switch isolates the instrument from the line supply. When switched to the **On** position, the instrument powers up and automatically selects its DC 1000V range.

After ½ hour, the instrument is near to its full specification, but should be left on for 2 hours before use if full accuracy is required.

Function keys

The four keys 'PRT', 'kΩ', 'AC' and 'DC' – provide the means to select the mode of operation of the instrument and contain LED indicators that light to show the selected function.

'Zero'. This facility is available on all DC voltage and Ohms ranges, by manual or systems operation.

When the 'Zero' key is pressed, the DMM

a) accepts the measured input as a zero offset for the range selected, providing it does not exceed approx 1.5% of full range.

b) stores the offset value in non-volatile memory.

c) compensates ALL SUBSEQUENT READINGS taken on that range by the stored offset value, until the user redefines the zero.

If the measured input offset exceeds 1.5% of full range from the calibrated DMM zero, no offset is stored and the Error 4 message is displayed.

A separate zero offset correction is stored for each range. When the DMM is in 'Auto' during the Zero routine, all ranges are zeroed automatically in ascending order.

CAUTION

The stored offset correction is applied to all readings, so that the correct procedure is to re-zero the DMM whenever the input zero condition is changed. Failure to observe this procedure will cause an incorrect zero compensation to be applied.

'Filter' key. The 'Filter' key is pressed to increase the normal mode AC noise rejection in measurement of DC volts, PRT or resistance. In Filter mode, a block average of 4 is set.

AC Filter keys. The AC Filter keys extend the low frequency response of the instrument to 10Hz, 1Hz or 0.1Hz.

Range select keys

The instrument range of inputs in each function is as follows:

10nV - 1,000V DC
.1μV - 1,000V true RMS AC
1μΩ - 20MΩ

Autorange ('Auto') key. This key commands the instrument to select the optimum ranges for the measurement, saving the operator this task and introducing very little delay.

Mode and compute keys

The function of these keys is given in Section 3.

4 wire/2 wire switch

During resistance measurements, this switch should be set to match the connection arrangement.

Local/remote guard switch

Selection of 'Local Guard' connects the front panel 'Guard' internally to the front panel 'Lo' terminal for voltage measurements, and to the front panel 'Ω Guard' terminal for resistance measurement.

Selection of 'Remote Guard' isolates the 'Guard' terminal from all others and enables a remote connection to be made from the internal guard screens to the source of any common mode voltage.

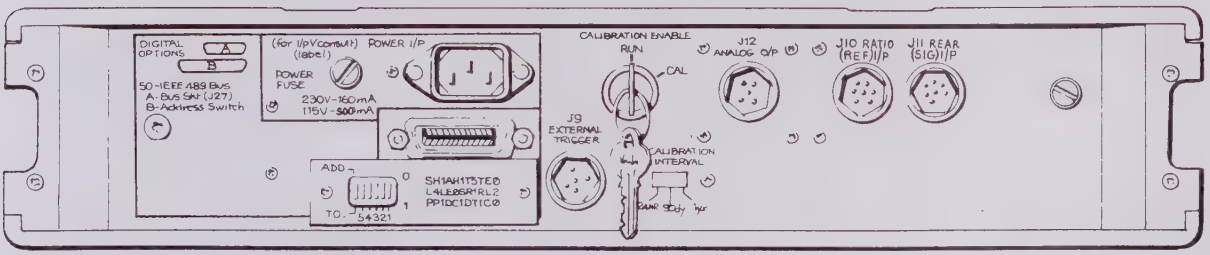


Fig. 2.2 Rear panel

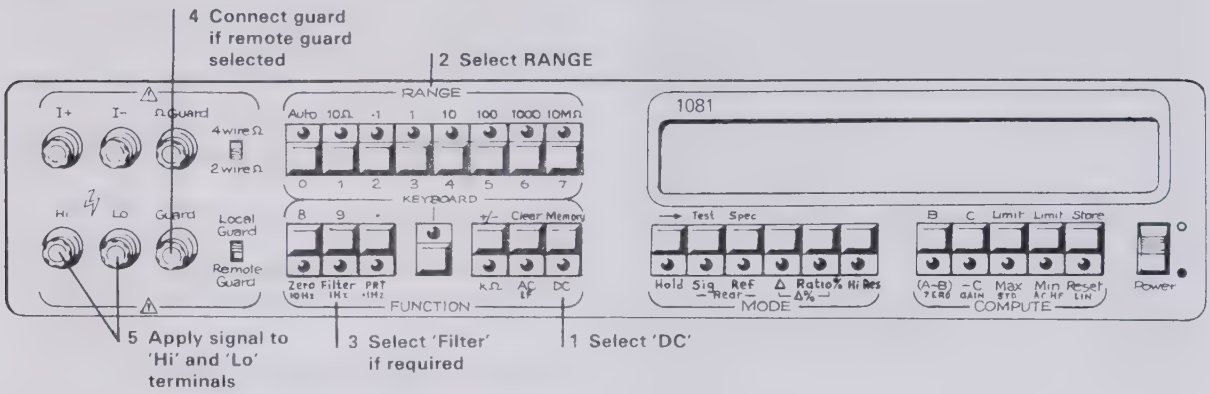
Calibration enable keyswitch

The calibration procedure is detailed in the Calibration and Servicing Handbook. The calibration switch is of the locking type to avoid accidental or unauthorised initiation of the calibration procedure.

Calibration interval switch

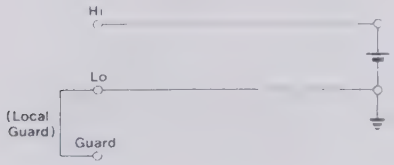
The calibration interval switch should be set to correspond with the intervals that elapse between re-calibrations of the DMM. The setting of the switch determines the selection of specification values displayed when the '→' then 'Spec' key is pressed (see Section 3 – Spec mode).

DC voltage measurement procedure 6½ digits


4 Connect guard if remote guard selected
2 Select RANGE
RANGE
Auto 10Ω ·1 1 10 100 1000 10MΩ
0 1 2 3 4 5 6 7
KEYBOARD
8 9 · +/- Clear Memory
I+ I- Guard 4 wire Ω 2 wire Ω
Hi Lo Guard Local Guard Remote Guard
1081
Test Spec
B C Limit Limit Store
Hold Sig Ref Δ Ratio Hi Res
(A-B) -C Max Min Reset
Power
MODE
COMPUTE
FUNCTION
Zero Filter PRT
kΩ AC DC
5 Apply signal to 'Hi' and 'Lo' terminals
3 Select 'Filter' if required
1 Select 'DC'

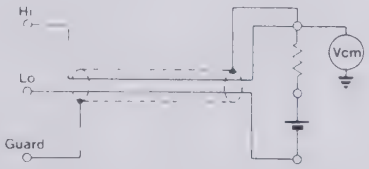
Simple lead connection

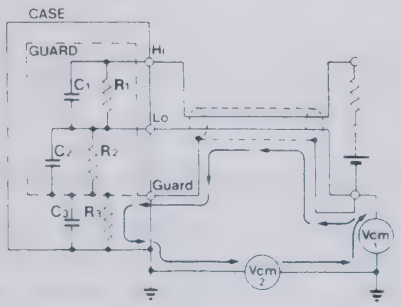
For the majority of applications the simple lead connection shown below with 'Local Guard' selected will be adequate. The disadvantage of this simple arrangement is that the connecting leads form a loop. If a stray alternating magnetic field, e.g. from the line transformer of a neighbouring instrument, passes through the loop it will behave as a single turn secondary winding inducing unwanted AC voltages into the measuring circuit. Use of a twisted pair will reduce the loop area as adjacent twists will automatically cancel any induced voltages. If problems with stray pick-up are encountered, it is recommended that a screened twisted pair cable be used with the screen connected to the 'Lo' or 'Guard' terminal.



Use of remote guard connection

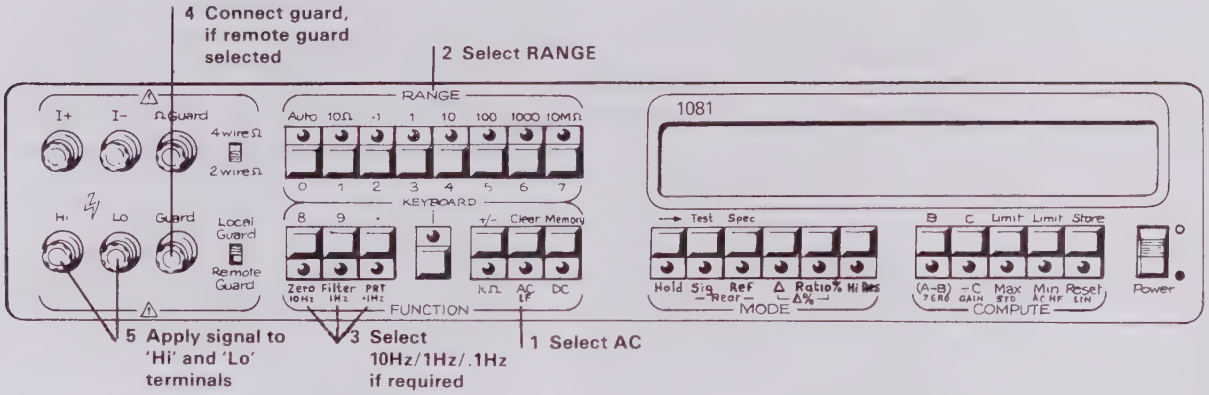
The 'Guard' terminal should be used with 'Remote Guard' selected when the source to be measured presents an unbalanced impedance to the measuring terminals and common mode voltages are present. Regardless of how the 'Hi' and 'Lo' terminals are connected, the 'Guard' terminal should refer to the source of common mode voltage. This will ensure that errors, caused by common mode currents flowing in the measuring circuits, are minimised by providing a separate common mode current path as shown in the examples below.





R1, C1 = Input impedance
R2, C2 = Input to guard leakage impedance
R3, C3 = Guard to case leakage impedance
Vcm1, Vcm2 = Common mode voltages

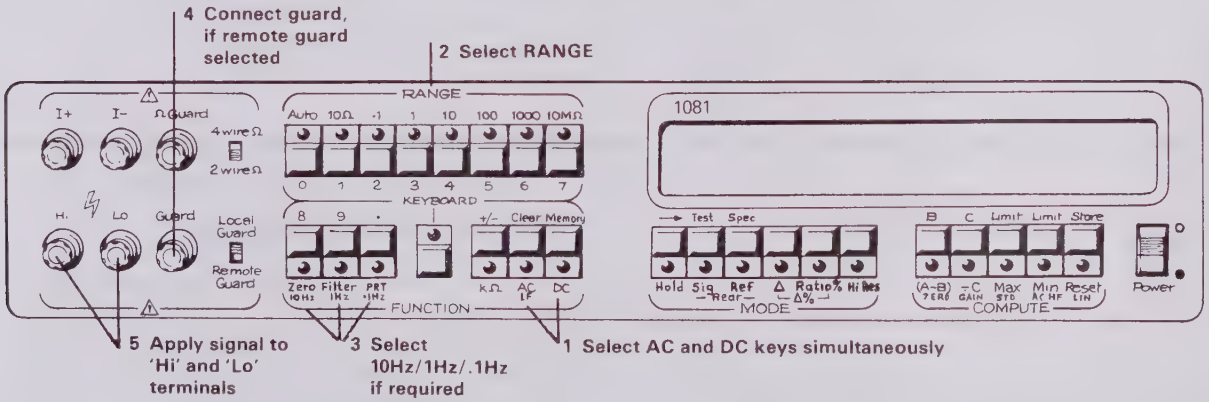
AC voltage measurement procedure 5½ digits



Low frequency measurements

To measure any signal of frequency below 100Hz to full accuracy, DC coupling MUST be selected as shown below. Selection of 10Hz, 1Hz or 0.1Hz filter, increases the settling time as shown in Section 6 – Specifications.

DC coupled AC voltage measurement procedure 5½ digits



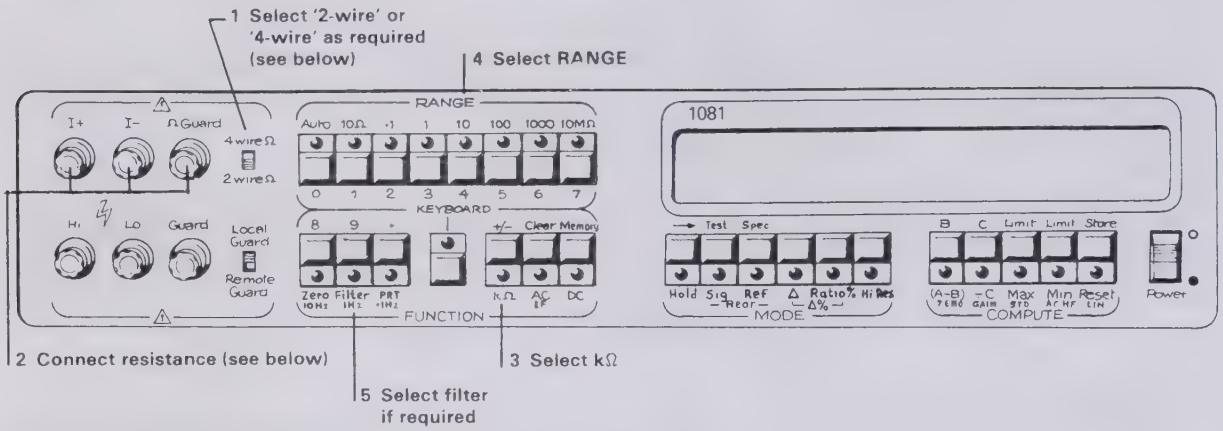
AC voltage measurement

Whilst for DC voltage measurement the resistance of the connection lead is generally unimportant so long as it is small compared with the input impedance of the measuring device, with AC voltage measurement the capacitance may give rise to an appreciable shunting effect causing source loading as well as voltage drop in the leads. The approximate 'Hi' to 'Lo' capacitance of the leads in the Datron lead kit are:
low thermal-emf lead with spade terminals—65pF,
other leads—160pF.
In extreme cases, use of separate leads will give lower capacitance (dependent upon spacing but typically 4pF) but will be liable to corrupt the measurement by adding induced signals. The table below gives the approximate impedances at different frequencies.

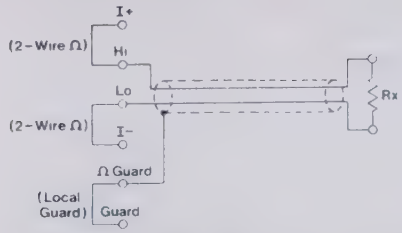
FREQUENCY	LEAD CAPACITANCE		
	4pF	65pF	160pF
100Hz	400MΩ	20MΩ	10MΩ
1kHz	40MΩ	2MΩ	1MΩ
10kHz	4MΩ	200kΩ	100kΩ
100kHz	400kΩ	20kΩ	10kΩ
1MHz	40kΩ	2kΩ	1kΩ

Table 2.4 Connection lead capacitance

Resistance measurement procedure



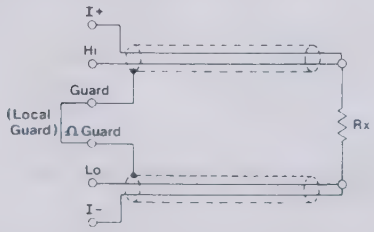
2-wire measurements



For the majority of applications, the simple 2-wire arrangement will be adequate. However, the value displayed will include the resistance of the connecting leads.

Use a screened twisted pair cable to reduce induced voltages, particularly where Rx is high.

4-wire measurements



With a 4-wire connection the lead resistances have negligible effect and only the value of Rx is displayed. The 4-wire connection, as shown above using two screened twisted pair cables, is also suitable for measuring high resistances with long cables since the effects of leakage and capacitance between leads is eliminated. When making very high resistance measurements the 'Ω Guard' terminal should also be connected to a guard screen wrapped around the resistor, or the case it is mounted in, to reduce any errors due to noise.

True 4-wire zero

For accurate measurements of Ohms it is ESSENTIAL that a correctly connected zero source is used when operating 'Input zero' before making a series of resistance measurements.

Two arrangements are shown below, depending upon the resistance to be measured, which ensure that thermal emf effects are eliminated.

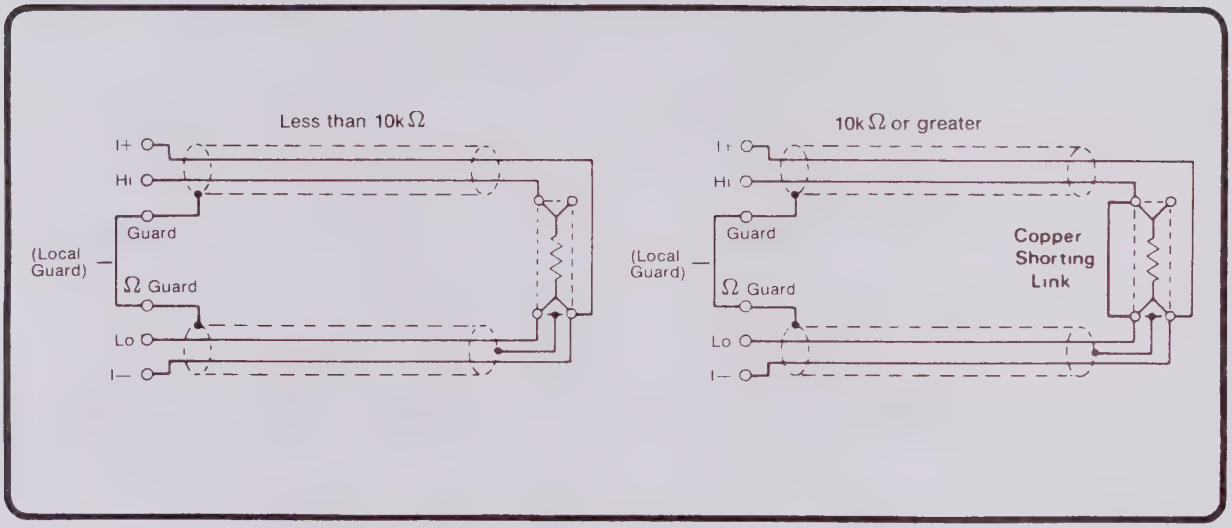


Fig. 2.1 Zero resistance source connections

'In-circuit' measurements

'Ω Guard' can be used to make 'in-circuit' resistance measurements by guarding out parallel resistance paths so that only the value of Rx will be displayed.

Similarly, 'Ω Guard' can be used to reduce the settling time if Rx is shunted by any capacitance and a suitable tapping point is available.

Providing that Ra and Rb are no less than 250Ω (1.5kΩ on 1000kΩ or 10MΩ Ranges), and the Ω Guard resistance (Rg) is less than 5Ω; the actual value Rx can be calculated from the displayed value Rd by:

$$Rx = Rd \times (1 + E).$$

Deviation fraction 'E' can be found within 1% by the simplified formula:

$$E = \frac{(Rd.Rg)}{(Ra.Rb)},$$

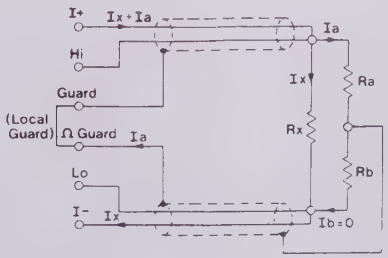
(Where Rg is the Ω Guard lead-resistance from the junction of Ra and Rb, +0.25Ω.)

Example:
If Rd = 100Ω, Rg = 1Ω, Ra = Rb = 10kΩ, then the value of E is given by:

$$E = \frac{100 \times 1}{10k \times 10k} = 10^{-6} \text{ (1ppm of reading);}$$

The value of Rx is thus given by:

$$Rx = 100.(1 + 10^{-6}) \text{ Ohms,}$$
$$= 100.0001 \text{ Ohms}$$



Rear signal input

The measurement source may be connected to the 'REAR SIGNAL I/P' plug instead of the front panel terminals when front panel 'Rear Sig' is selected.

For all rear panel inputs, the maximum limit is 250V RMS.

When using the rear panel input plug the front panel switches '4-wire Ω / 2 wire Ω' and 'Local Guard/Remote Guard' are inoperative. Therefore a connection must always be made to the 'Guard' pin H and for 2-wire resistance measurement external connections must be made from 'Hi' to 'I+' and 'Lo' to 'I−'.

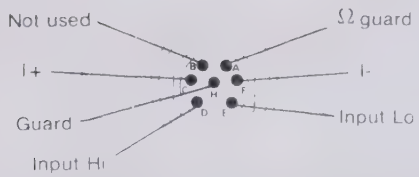


Fig. 2.2 Rear input 7 pin plug

Thermal EMF

Thermal emfs are significant in DC voltage and current resistance measurements, especially when measuring low voltages or large currents. These unpredictable thermal emf errors arise when dissimilar metal junctions are at different temperatures. To minimise thermal emf errors use the same material throughout the measuring circuit, particularly avoid the use of steel probes, nickel plated terminals and tinned copper wire. The table below shows thermal emfs relative to hard drawn copper at 23°C.

MATERIAL	EMF μV/°C
SILVER	+0.03
GOLD	+0.01
TIN	−3
LEAD	−3
NICKEL	−22

If dissimilar metal junctions are used ensure that they are offset by other junctions of the same material at the same temperature and allow for thermal emfs by making the measurement twice with reversed polarity.

A lead with gold plated copper terminals is provided in the Datron lead kit for making low thermal emf connections.

Display messages

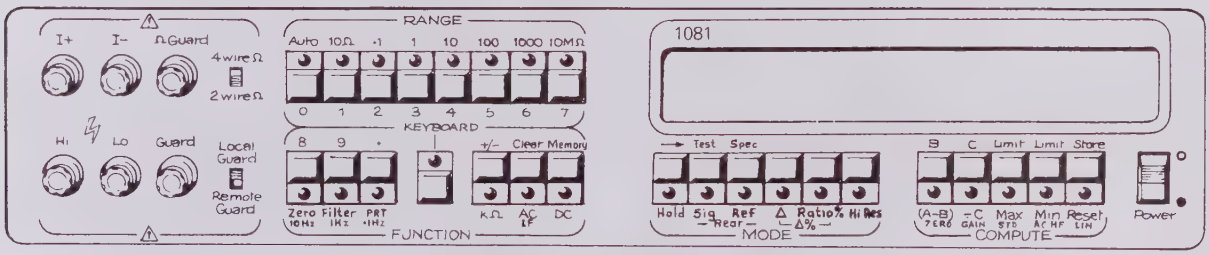
Alpha numeric messages will appear on the display when an input, computational or memory error occurs. A message will also appear when a limit is transgressed and during the self test routine.

Message	Cause	Correction
Error O L	Overload 199999(9)	Reduce input signal or up range
Error 1	Arithmetic Overflow	Adjust C store, rear signal or reference input
Error 2	Invalid Data Entry/Recall	Adjust Data value/Recall
Error 3	Spec > 100% or unspecified	
Error 4	Zero or calibration input error	Adjust applied input and repress key
Error 5	DC Self Test failure	Refer to Calibration & Servicing Handbook
Error 6	kΩ Self Test failure	
Error 7	AC Self Test failure	
Error 9	Arithmetic Underflow	Adjust C store, rear signal or reference input
IP·O	Zero memory error	Repeat input zero procedure
FAIL	Calibration memory error	Refer to Calibration & Servicing Handbook
Hi Lt	Hi Limit transgressed	
Lo Lt	Lo Limit transgressed	
Err Lt	Hi and Lo Limit transgressed	Amend limit values
PASS & Legend	Self Test pass message	
Cont	Continuous Average mode selected	

SECTION 3 ADVANCED OPERATIONAL PROCEDURES

The procedures for exercising the features that supplement the basic measurement functions of the instrument are detailed in this section.

External triggers and 'Hold'



When the instrument is under local control, readings are taken at a rate in accordance with its internal read rate specification. When the 'Hold' key is pressed the reading in progress is completed and displayed, but no further readings are taken.

The DMM measurement cycle can be triggered externally, after the internal trigger has been disabled by pressing the 'Hold' key. The trigger occurs on a high to low edge. The external trigger connector is on the rear panel, connection arrangement is shown in Fig. 3.1.

If 'Hold' and 'Auto' are both selected, when triggered, the instrument will change range as required before a reading is taken and held.

Pressing 'Hold' again returns the instrument to its free running condition.

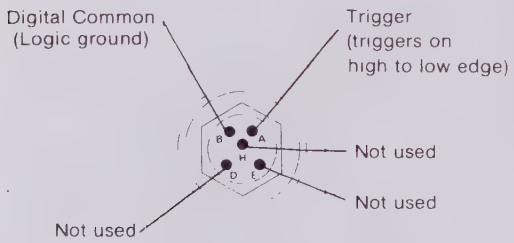
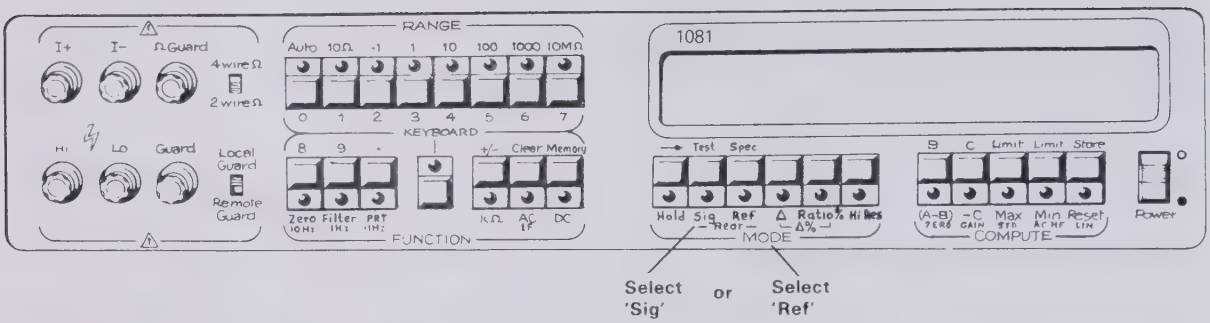


Fig. 3.1 External trigger 5-pin plug

Rear inputs



The two rear input plugs REAR SIGNAL, and REFERENCE can be used as extra signal inputs (250V RMS max) by simply pressing the appropriate key on the front panel.

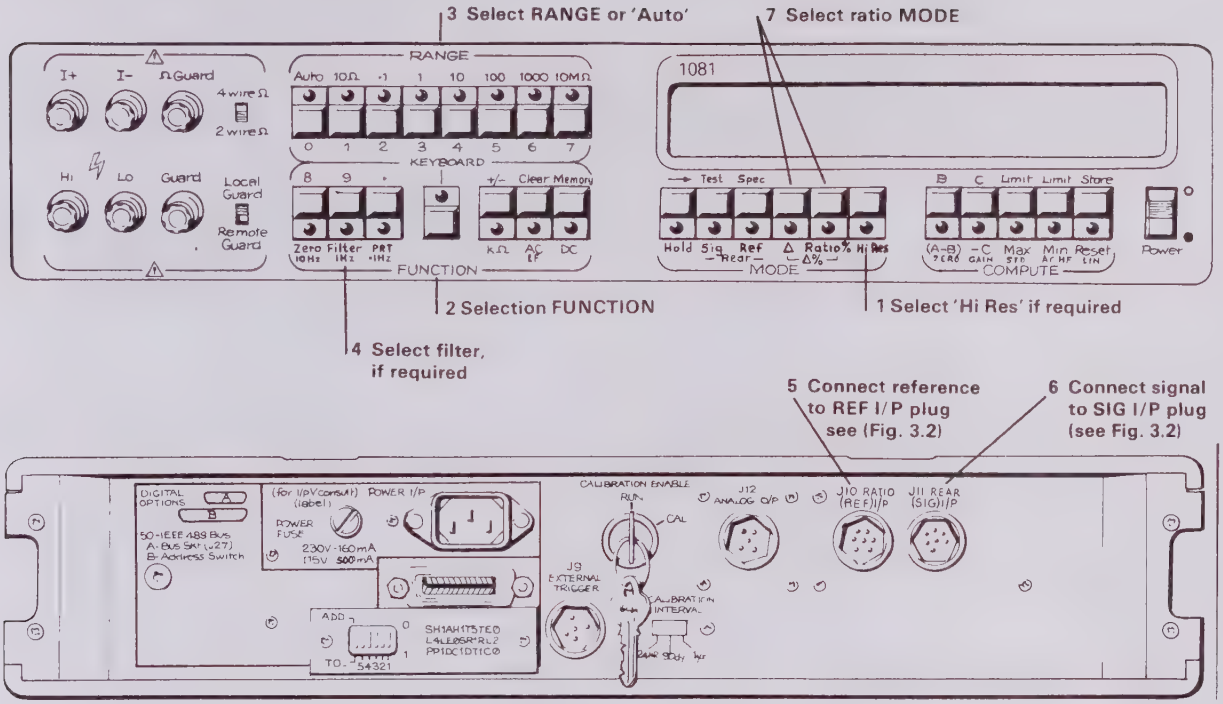
When using rear inputs, Guard is remote and Ω Functions are connected as 4 wire.

For Local Guard, connect 'Guard' to 'Lo' for Voltage functions and to 'Ω Guard' for Ω Functions.

For 2 wire Ω, connect 'Hi' to 'I+', and 'Lo' to 'I−'.

The front 4 wire/2 wire switch and Local/Remote Guard switch are inoperative in rear input modes.

Ratio measurement procedure



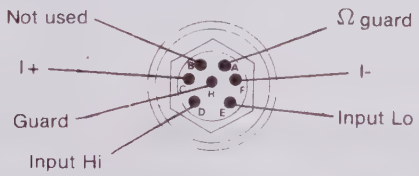


Fig. 3.2 SIG and REF inputs 7-pin plugs

The ratio of any two similar function inputs can be displayed by following the procedure shown above. If 'Auto' is selected the two inputs may be of widely different magnitude, although maximum permissible input voltages are limited to 250V RMS when using the rear input plugs.

With the following selections, the display will show a value equal to:

$$\text{'Ratio\%'} = \frac{\text{Rear Signal}}{\text{Ratio Reference}} \times 100\%$$

$$\text{'}\Delta\text{'} = \text{Rear Signal} - \text{Ratio Reference}$$

$$\text{'}\Delta\,\%\text{' (both 'Ratio\%' and '}\Delta\text{')} = \frac{\text{Rear Signal} - \text{Ratio Reference}}{\text{Ratio Reference}} \times 100\%$$

An Error 1 indicates an arithmetic overflow
Error 9 indicates an arithmetic underflow

In either case the REF or SIG input signal should be adjusted until a valid ratio reading is obtained.

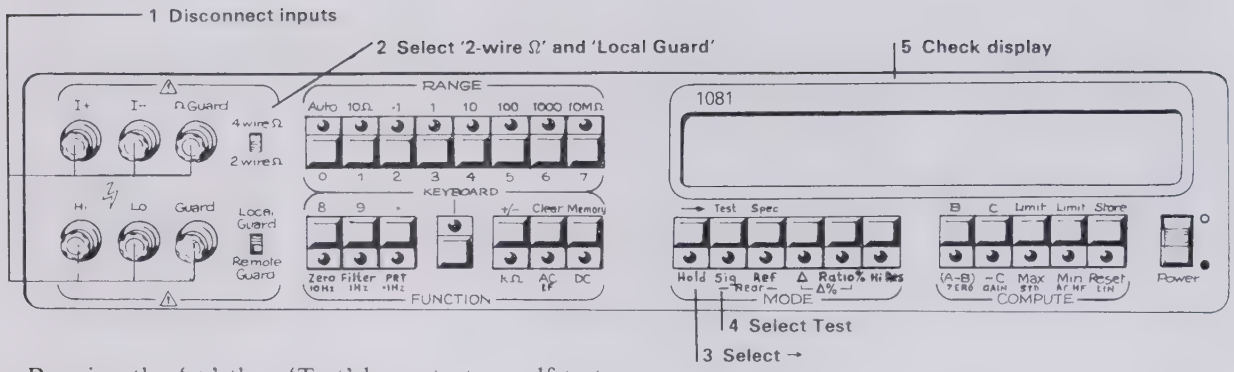
Deselection of this mode is made by repressing the 'Ratio %' key and/or 'Δ' key (whichever mode is selected).

Example of ratio measurements

The instrument's AC converter is a true RMS DC coupled unit, making it possible to perform AC:DC ratio measurements. When used in this way, with an AC source compared with an accurate DC source, the instrument operates as an automatic AC/DC transfer standard with a transfer accuracy as shown in specification section.

Transfer standard measurements should be made with the instrument set to take DC coupled AC measurements (see section 2). Connect the DC source to the SIG input plug and the AC source to the REF input plug, a displayed reading of 100% indicates an equalized state.

Self test



Pressing the '→' then 'Test' keys starts a self test routine. The self test is a part visual, part internal check of the proper operation of the instrument. A visual check is made of the display by the operator and internal checks are executed to verify that the circuits are functioning correctly. Self Test does not check the full measurement accuracy of the instrument.

ALL MEASUREMENT INPUTS SHOULD BE LEFT OPEN CIRCUIT.

'2 wire Ω' should be selected.

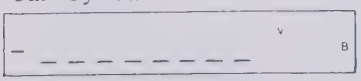
Self test sequence

The routine after pressing 'Test' is as follows:-

1. Turns off all key LEDs.
2. Display cleared.

Visual check sequence

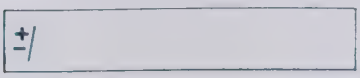
3. Seven segment digits and legends illuminated 'bar' by 'bar'.



4. All decimal points displayed.

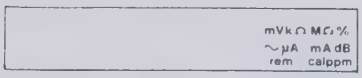
5. All commas displayed.

6. Polarity signs and overrange digit displayed.



7. Seven segment digits displayed digit by digit.

8. First then second block of legends displayed.



9. Display cleared.

Internal check sequence

		PASS indication:
10.	Check Ratio.	Adds % legend to display.
11.	Check DC volts. If the following options are not fitted, the routine passes on to the next step.	Adds V legend.
12.	Check Ohms.	Adds Ω legend.
13.	Check AC volts.	Adds ~ legend.
14.	A check is made of the non-volatile memory (i.e. the calibration and input zero memory).	PASS

When the test routine is completed successfully, the instrument will retain the 'PASS' indication. Pressing 'Hold' will return the instrument to the last selected range and function but all mode and compute functions are cancelled.

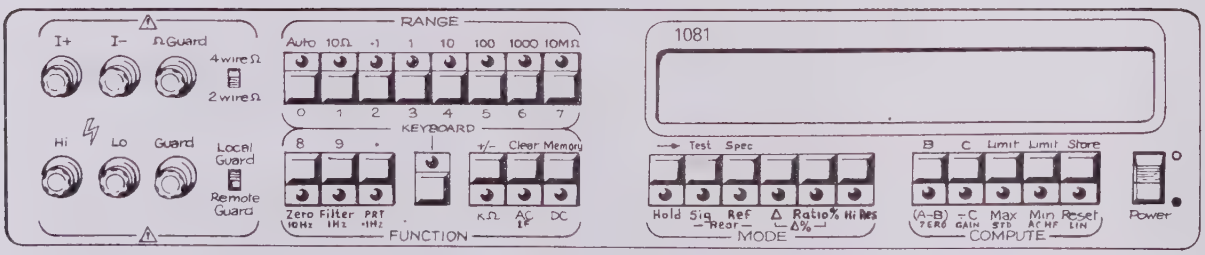
When the 'Test' routine finds an error in the internal checks, an Error message will be held on the display. To clear this state and continue with the self test routine, press 'Test'. Refer to Calibration and Servicing Handbook for fault finding procedure.

An Error 5 indicates DC failure
Error 6 indicates kΩ failure
Error 7 indicates AC failure

FAIL indicates Calibration memory error.

Selecting 'Auto' during 'Test'. The instrument cycles through the test procedure until either a fault appears or 'Auto' is deselected. The instrument then finishes the test sequence in progress.

Spec mode



Depressing '→' then 'Spec' keys causes the instrument to compute and display an error value that relates to the last measurement made. The instrument contains a table of the measurement specification for every function and range, and the maximum limits of uncertainty for the last displayed measurement is displayed as a fraction of that measurement.

This uncertainty value is only available for the measurement itself, not for the computed value of the reading (see 'Computation facility'). Nor is the error value available for 'Hi Res' Mode readings (see 'Hi Res' Mode).

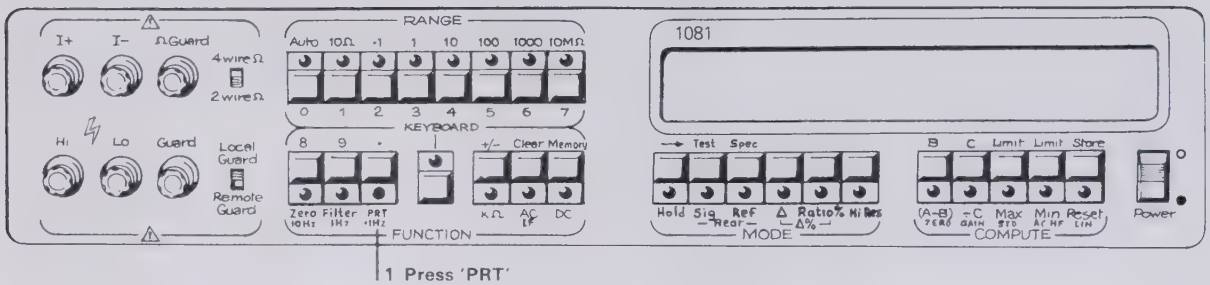
The uncertainty is calculated according to the setting of the calibration interval switch on the rear panel so that the instrument's specification is examined in the area that corresponds to the chosen re-calibration interval.

The display is preceded by a + / − indication and is in ppm or %, depending on magnitude. Very large % errors, such as at near-zero readings, are displayed as a message (Error 3).

Depressing the '→' key again, returns the instrument to normal operation.

Platinum Resistance Thermometer measurements

Temperature Display



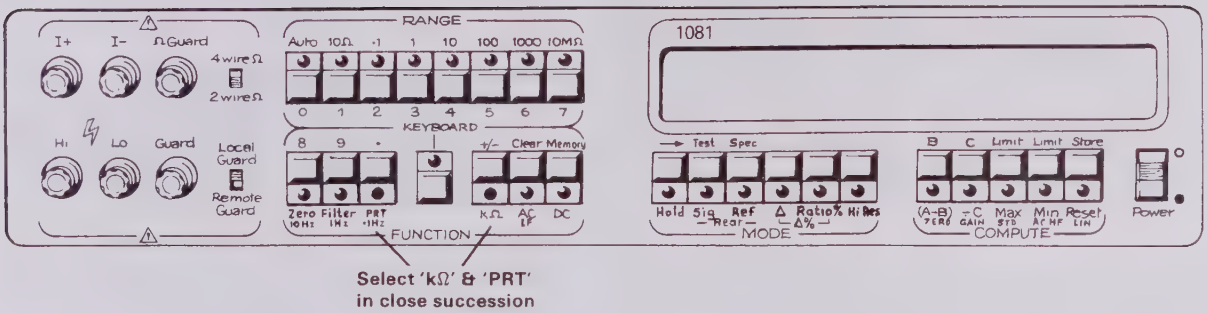
The 1081 can be used with any 100Ω PRT with a 'fundamental interval' of 38.5Ω to produce a direct readout of temperature in °Celsius.

First ensuring 'AC' is not selected, then selecting 'PRT', will automatically provide a 1mA current source at the input connector and produce a display in °C. Normally, 4 wire connections to the PRT are provided, therefore '4 wire Ω' should be selected on the front panel if the front panel input terminals are being used.

For optimum conformity, calibration constants for individual PRTs can be entered using 'Keyboard' when calibration is carried out – refer to Calibration and Servicing Handbook.

A Datron accessory, PRT 100 Platinum Resistance Thermometer Probe, is available for use with the 1081. It is fitted with a mating connector for either rear panel input socket. In this case, either 'Rear' then 'Sig' or 'Ref' should be selected.

Resistance Display



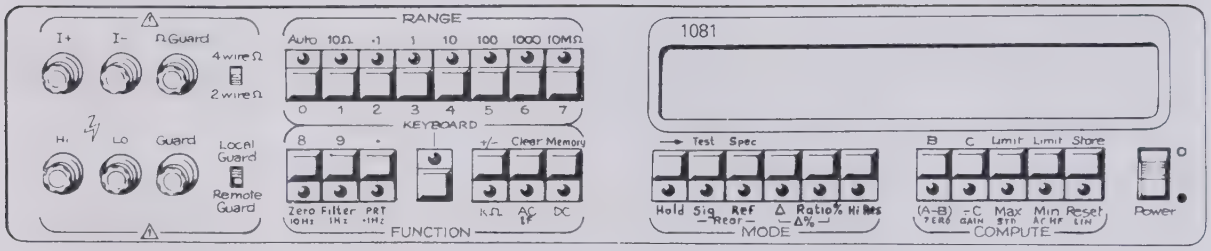
As an alternative to a display readout in °Celsius, a special 'kΩ' range is provided for readout in ohms. This enables the 1081 to be used with PRT probes having other basic resistances and fundamental intervals. Temperature conversion can be made using appropriate tables.

By selecting 'kΩ' and 'PRT' in close succession a fixed 100Ω resistance range is selected with a source current of 1mA provided at the input connector.

The 1081 now operates as for a normal Resistance measurement. '4 wire Ω' or '2 wire Ω' should be selected as appropriate if using the front panel connectors.

Selection of Hi Res will extend the display to 7½ digits.

Hi Res mode measurements



Selection of 'Hi Res' with DC or kΩ functions extends the display to 7½ digits and with AC volts a display of 6½ digits is produced.

In this mode, the displayed reading up to the 15th measurement is the mean of all measurements since pressing the 'Hi Res' key. On the 16th and subsequent measurements the displayed reading is the mean of the 16 most recent measurements, and the resolution is increased to 7½ digits. The technique used to achieve this involves internally offsetting each reading from the next by approximately $\frac{1}{16}$ digit before the final displayed reading is obtained. In this way, and providing 'Filter' is selected, a useful increase in accuracy, of typically two times or greater, is achieved. An example of the method is shown diagrammatically in Fig. 3.3.

'Hi Res' deselects 'Auto' ranging. 'Auto' or 'Cal' deselects 'Hi Res'.

To deselect 'Hi Res' mode press the 'Hi Res' key again.

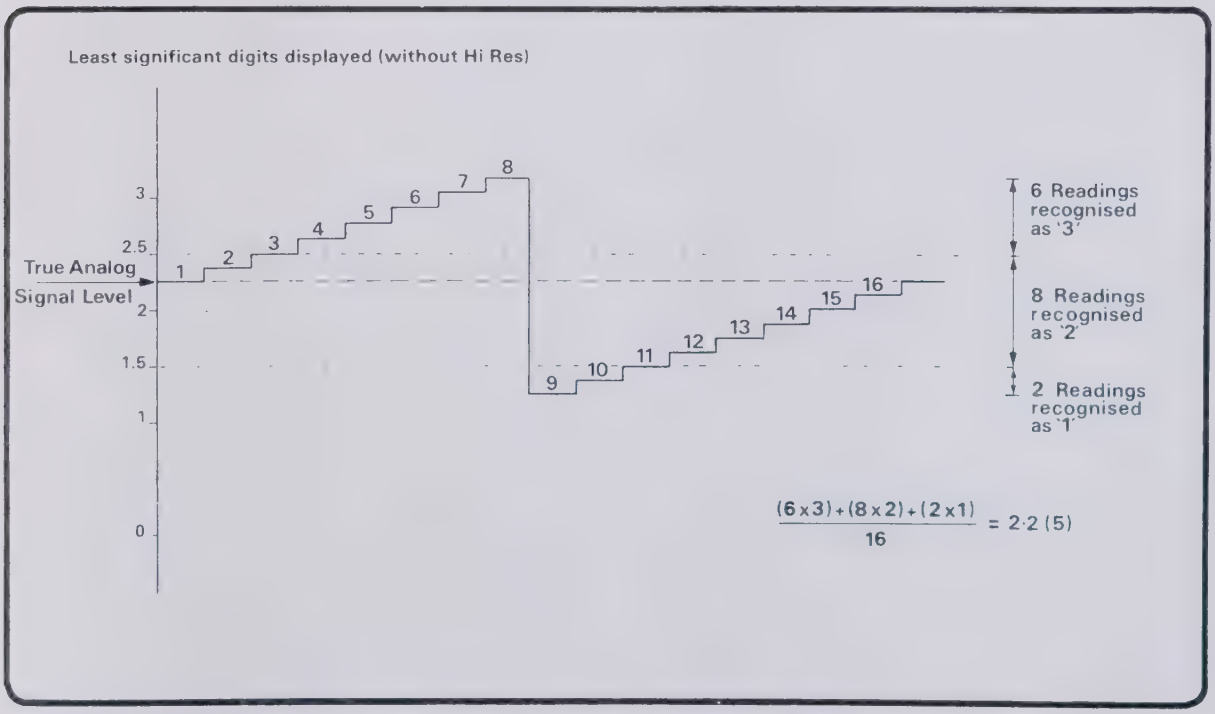


Fig. 3.3 DIAGRAM OF HI RES PROCESS

Other 'Hi Res' modes

In addition to the normal 'Hi Res' mode of averaging, two other methods are available called 'Cont' and 'Block'.

Cont – continuous averaging

This mode is selected by pressing 'Hi Res', then 'Keyboard', '∅', 'Store', 'Hi Res'.

The displayed reading is then the arithmetic mean of all the measurements taken since making this selection. An increase in resolution is provided by an extra digit, displayed after the first reading.

The average store has a capacity of 2^{22} measurements, leading to an overflow after approximately 24 days at 2 measurements per second. This store is reset whenever this mode is selected or a range or function change is made.

To deselect 'cont' mode, press the 'Hi Res' key again. Reselection of 'Hi Res' selects Normal 'Hi Res' mode.

Block mode

This mode is selected by pressing 'Hi Res', then 'Keyboard' then a number from 1 to 19,999, then pressing 'Store' 'Hi Res'. This sets the block size to the required number. A 'Block' is a preset number of measurements, taken at the maximum internal read rate, on receipt of a block trigger.

After completing a block of measurements, the 1081 displays and holds a single reading, which is the arithmetic mean of all measurements in the Block.

A 'single shot' block may be performed by using 'Hold' with an external trigger. Subsequent triggers during a block will be ignored. To deselect 'Block' mode press the 'Hi Res' key again. Reselection of 'Hi Res' selects Normal 'Hi Res' mode.

Computation facility

Four compute stores exist labelled B, C and Limits which can be loaded with any number from the display. This means that either a previous reading or a manually entered display using the 'Keyboard' feature can be used. These stores can then be used in a variety of ways to usefully extend the measurement capability of the instrument.

Entry of constants

The secondary use of the range and function keys as a keyboard is achieved by pressing the 'KEYBOARD' key. The display clears, apart from a '0' as the least significant digit. Digits and decimal points are then entered from the keyboard. The sign of the value keyed may be changed at any time by pressing the '+/−' key.

If an error is made, the entire display can be cleared by pressing the 'Clear' key.

Recall store

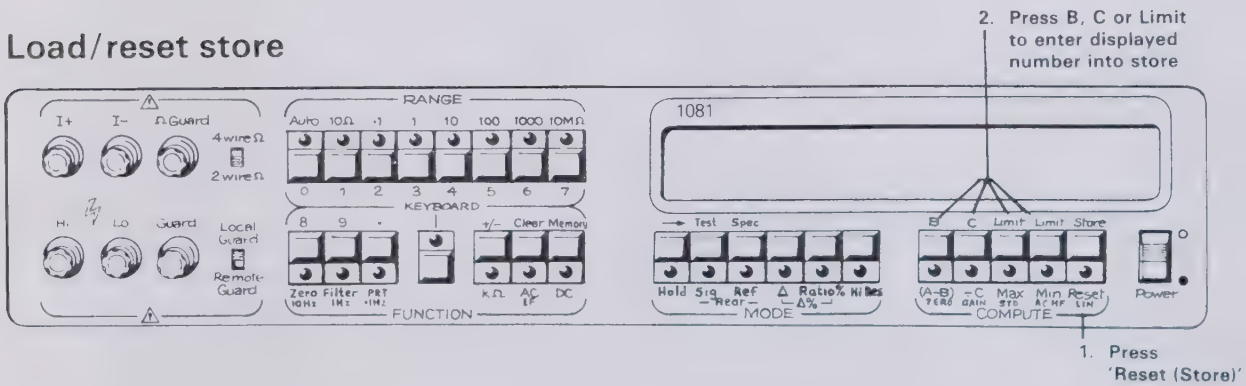
The number in any of the four computational stores may be displayed at any time by pressing the 'KEYBOARD' key, followed by the appropriate 'COMPUTE' key. Pressing 'KEYBOARD' again returns the instrument to the previous setting.

The units of the recalled number are dependent upon the function selected and legend displayed as shown below.

FUNCTION	LEGEND	UNITS
V	NONE	V
	m	mV
	k	kV
kΩ	NONE	kΩ
	m	Ω
	k	MΩ

e.g. with 'kΩ' selected 2.5 recalled indicates a stored value of 2.5kΩ and 2.5k recalled indicates a stored value of 2.5MΩ.

Load/reset store



In order to load a compute store with the displayed number, press the 'Reset (Store)' key followed by the required store location ('B', 'C' Limit (max)' or 'Limit (min)'). The number is then loaded, extinguishing the 'Reset (Store)' LED and returning the instrument to its original setting.

The stored number assumes the units displayed for the range being used i.e. 2.5 entered on the '10kΩ' range results in a stored value of 2.5kΩ and 2.5 entered on the '10MΩ' range results in a stored value of 2.5MΩ.

(A-B)

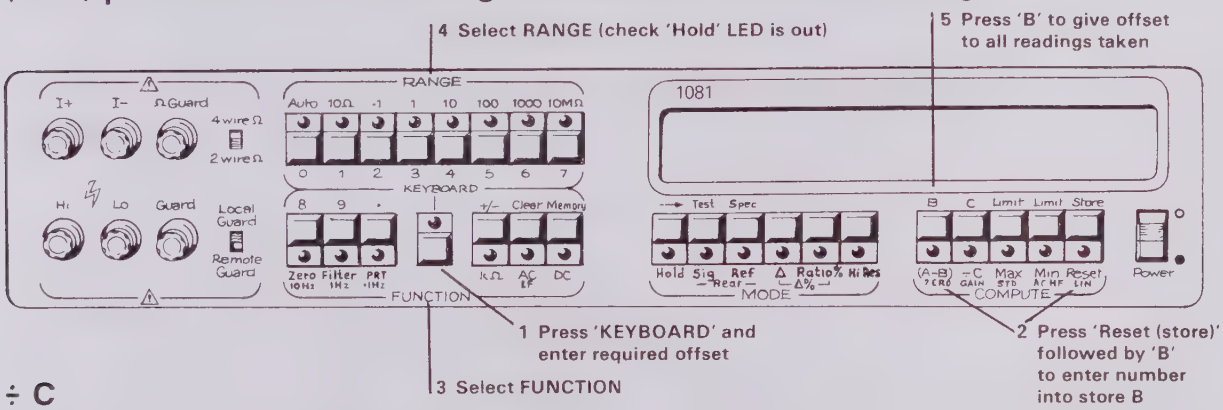
Pressing the (A-B) key gives measurements a constant offset, B, to be subtracted from the true reading, A. The offset must lie in the range.

$$10^{-7} \leq |B| < 2 \times 10^{+7}$$

The (A-B) LED is lit to show that the instrument is operating in this mode. Repressing (A-B) returns the instrument to normal operation, with stored value in B for later use.

(A-B) may be used in conjunction with ÷ C, Ratio, and Hi Res mode.

(A-B) procedure: Subtracting an offset from each reading


4 Select RANGE (check 'Hold' LED is out)
5 Press 'B' to give offset to all readings taken
RANGE
1081
1 Press 'KEYBOARD' and enter required offset
2 Press 'Reset (store)' followed by 'B' to enter number into store B ('Keyboard' and 'Reset (store)' LEDs go out).
3 Select FUNCTION

÷ C

Selection of ÷ C allows measured readings to be divided by a constant C × 100%. The constant must lie in the range

$$10^{-7} \leq |C| < 2 \times 10^{+7}$$

(To multiply the measured reading by a constant, enter its reciprocal multiplied by 100 into Store C.)

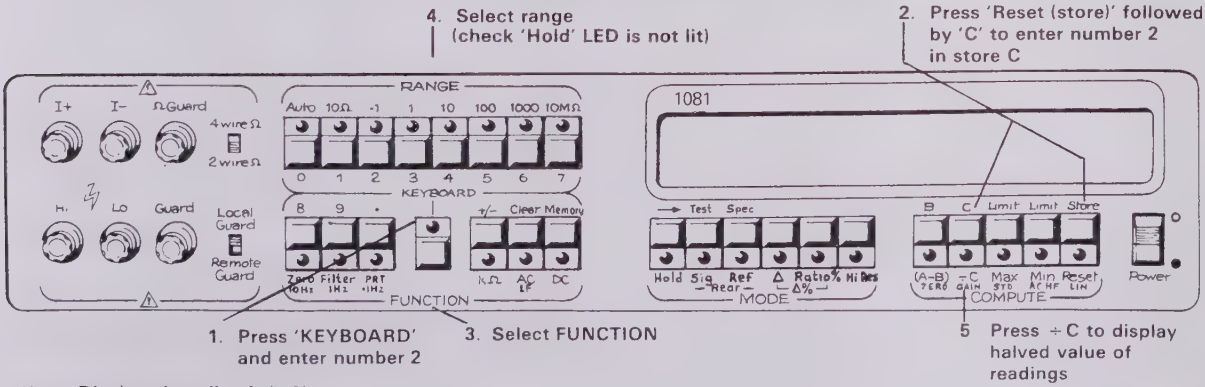
The ÷ C key LED lit indicates that the instrument is operating in this mode. Repressing ÷ C returns the instrument to normal operation, with the stored value in C for later use.

÷ C may be used in conjunction with (A-B), Ratio and Hi Res mode.

A display of:
Error 1 indicates an arithmetic overflow.
Error 9 indicates an arithmetic underflow.

In either case the value in the C store should be adjusted.

÷ C Procedure: Continuously halve all measurements

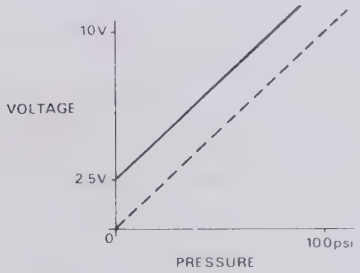

4. Select range (check 'Hold' LED is not lit)
2. Press 'Reset (store)' followed by 'C' to enter number 2 in store C
RANGE
1081
1. Press 'KEYBOARD' and enter number 2
3. Select FUNCTION
5 Press ÷C to display halved value of readings

Note: Displayed reading is in %.

Examples of measurement using (A-B) and ÷C

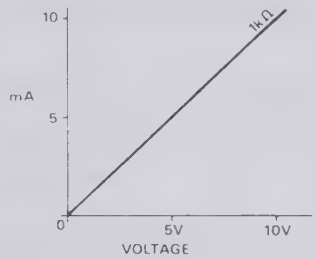
To remove the zero offset of a pressure transducer.

Most pressure transducers have a standard offset of a few volts at 'zero' pressure. This offset may be removed from subsequent readings by storing the constant in store 'B' and placing the instrument into '(A-B)' compute mode.



To compute the current flowing through a known resistance.

Using the simple formula I = V/R the value of I may be obtained by measuring the voltage developed across the resistance. The value of R, say 1kΩ, is placed into store 'C' and the instrument used in the ÷C compute mode. The displayed reading then indicates the current in milliamps.

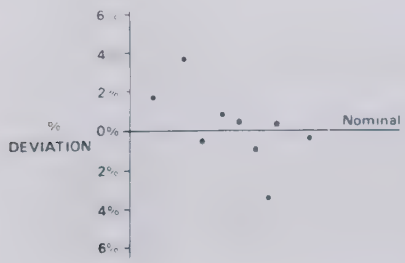


To check a particular component is within its stated tolerance.

Suppose we have a batch of 39kΩ ±5% resistors and we wish to know each resistor's percentage deviation from nominal. The equation

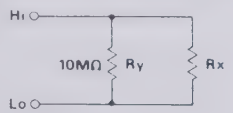
$$\frac{A-N}{N} \times 100$$

gives the percentage deviation from nominal, requiring the entry of the nominal value into both B and C stores. Selecting '(A – B)' and ÷C compute modes gives a direct read-out of percentage deviation.



To measure a resistance greater than 20MΩ

By connecting a 10MΩ resistor in parallel with Rx and using the '(A – B)' and '÷C' compute modes large resistances can be measured and displayed.



$$Rx = \frac{Ry\ Rz}{Ry - Rz}$$

Where Rz = Rx in parallel with Ry.

Measure Ry and store in store 'B'.
Select '(A – B)' and measure Rz (display reads Rz-Ry).
Store –10 (Rz-Ry) in store 'C', using the 'Keyboard' mode and select '÷C'.
The display now reads Rx in MΩ (% legend displayed) and the accuracy of the reading approximates to the accuracy of the DMM when measuring a value equal to

$$\frac{Rx}{Rz} \times \text{Acc. Rz}$$

Use short screened leads to reduce any errors due to noise.

Max and min

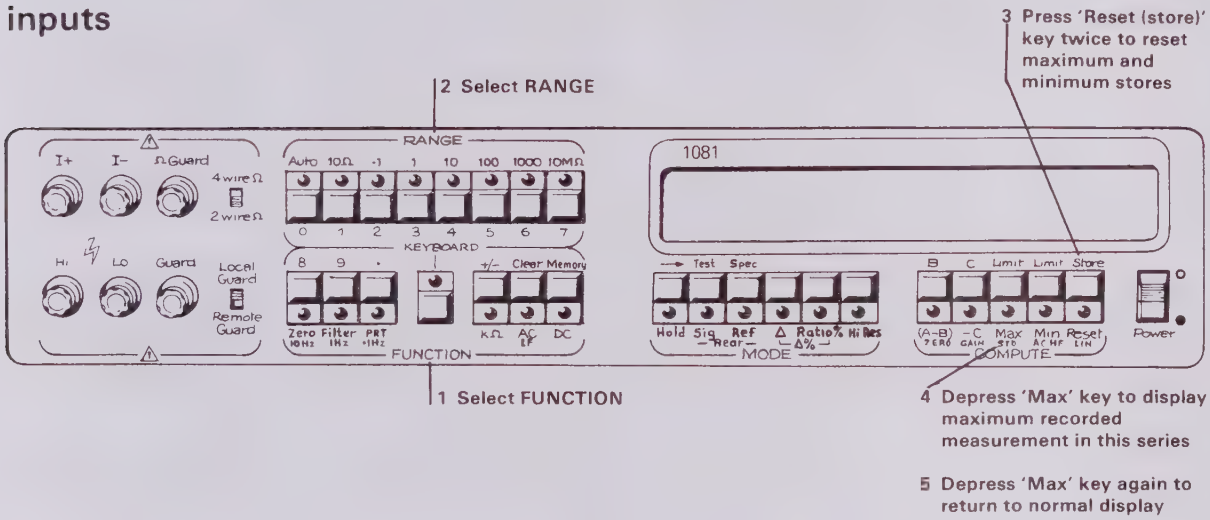
Selection of 'Max' or 'Min' causes the display to indicate the maximum or minimum reading since the stores were last reset. Each time the measured value is outside the current maximum or minimum, the appropriate store is updated.

The 'Max' and 'Min' stores are reset by pressing 'Reset' twice, changing function or passing into or out of 'Ratio' 'Δ' or 'Δ%' mode, after which the maximum and minimum displayed values are again retained and updated.

Simultaneous selection of 'Max' and 'Min' gives a maximum-minimum indication, i.e. a peak to peak indication of the readings since the stores were last reset.

NOTE: 'Limit' operation is also cancelled when the stores are reset.

Max and Min procedure: Displaying the maximum value of a series of inputs


3 Press 'Reset (store)' key twice to reset maximum and minimum stores
2 Select RANGE
RANGE
Auto 10Ω 1 10 100 1000 10MΩ
1081
I+ I− Guard 4 wire Ω 2 wire Ω
Hi Lo Guard Local Guard Remote Guard
KEYBOARD
Test Spec
Limit Limit Store
Zero Filter PRT
Hold Sig Ref Δ Ratio% Hi Res
Max Min Reset
Power
FUNCTION
MODE
COMPUTE
1 Select FUNCTION
4 Depress 'Max' key to display maximum recorded measurement in this series
5 Depress 'Max' key again to return to normal display

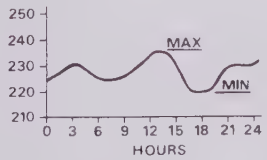
Example of Max and Min measurement

To find the maximum and minimum line supply voltage over 24 hours.

The instrument automatically keeps a record of maximum and minimum readings. Therefore once the DMM voltage has been set to monitor the input voltage (i.e. AC Volts, 1000V range, filter in), the run may be started by clearing the stores (press 'Reset' twice).

During the run the instrument can be set to display individual readings, the maximum or the minimum without store corruption.

On completion of the run, selecting 'Max' or 'Min' causes the instrument to display the maximum or minimum readings respectively.



Limits

High and low limit values are placed into the 'Limit' stores so that when these values are transgressed a display message is shown. Limit operation is cancelled (and the limit values lost) by pressing 'Reset' twice, changing function or passing into or out of 'Ratio %' 'Δ' or 'Δ%'.

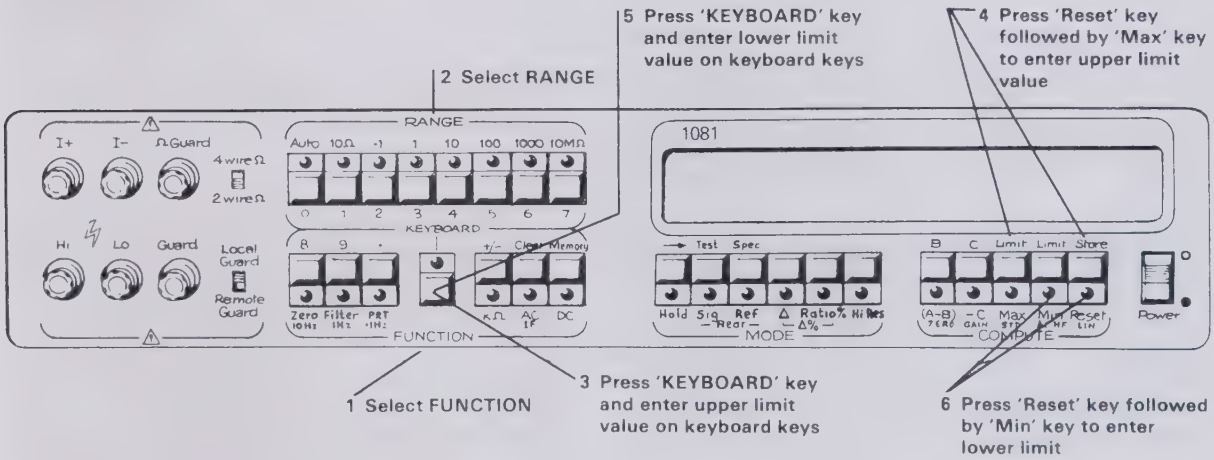
NOTE: 'Max' and 'Min' stores are also reset when cancelling the 'Limit' operation.

The value of a limit can be entered independently of the range selected, i.e. 100.000V limit can be entered with 0.1V range selected.

The display of an out of limit reading is as follows:

Hi Lt – indicates Hi Limit transgressed.
Lo Lt – indicates Lo Limit transgressed.
Err Lt – Lo Limit has been set higher than Hi Limit.

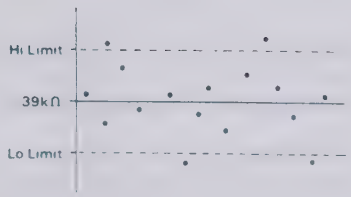
Limits procedure: Setting upper and lower limits


5 Press 'KEYBOARD' key and enter lower limit value on keyboard keys
4 Press 'Reset' key followed by 'Max' key to enter upper limit value
2 Select RANGE
RANGE
1081
KEYBOARD
FUNCTION
MODE
COMPUTE
Power
1 Select FUNCTION
3 Press 'KEYBOARD' key and enter upper limit value on keyboard keys
6 Press 'Reset' key followed by 'Min' key to enter lower limit

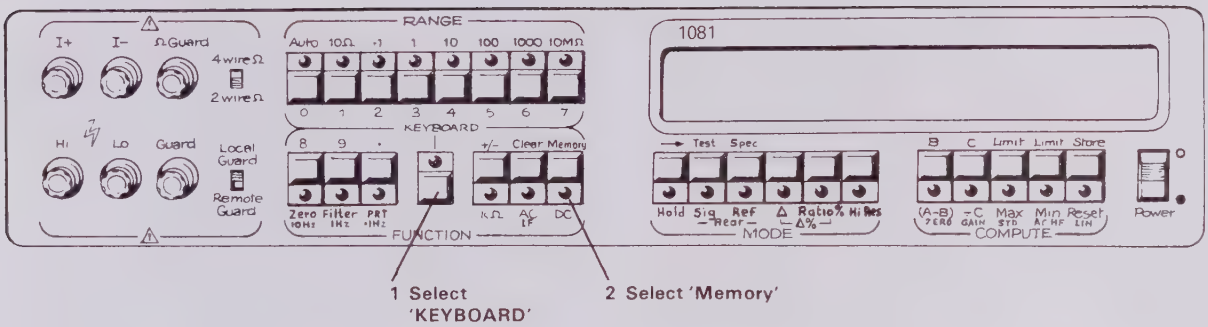
Example of Limit measurement

To use the limit mode for 'in specification' selection.

Consider the fabrication of 39kΩ±5% resistors. To meet the tolerance specification the resistor value must lie in the range 37.05kΩ to 40.95kΩ. The first step is to set the DMM to monitor the resistor value (kΩ, 100kΩ range, 2-wire Ω) then using the keyboard mode, place 37.05 in the min limit and 40.95 in the max limit ('Keyboard' 37.05, 'Reset', 'Min' limit, etc.). The samples may then be measured, the display messages Hi Lt and Lo Lt showing out of tolerance samples.



Recall memory



The 'Memory' store available to the user to retain information such as the last date of calibration, serial number, etc. can be displayed. By selecting 'KEYBOARD' followed by 'Memory' the contents of the eight character store will be shown on the display, e.g. 02.03.82. Normal operation can be restored by pressing 'KEYBOARD' again.

This store can only be loaded with new data when the instrument is in the calibration mode – refer to the Calibration and Servicing Handbook.

SECTION 4 SYSTEMS APPLICATION VIA THE IEEE INTERFACE

The IEEE interface option allows the instrument to form part of a system, outputting measurement data to other parts of that system. In addition, the DMM can be instructed via the interface so that the instrument's facilities can be selected remotely.

In order that instruments from differing manufacturers can be built into the same system, it is necessary that all interfaces are compatible. To ensure this, the interfaces conform to a standard specification as detailed in the publication ANSI/ IEEE Std 488-1978 called 'IEEE Standard Digital Interface for Programmable Instrumentation'.

A typical system is shown in Fig. 4.1. The system is driven by a controlling device able to issue commands (controller), receive data (listener) and output data (talker). The DMM is able to receive programming information (listener) and to output data (talker). A device such as a printer or VDU will simply input data (listener), its output not being into the system, but onto paper or the screen. The signal scanner is also a listener only, receiving only commands. Neither its signal input or output are directly connected to the interface bus.

If a system comprises several instruments, the controller is able to communicate with the instruments individually through the assignment to each of a different 'address'. The controller adds information to the address to define either talk or listen.

In the system example (Fig. 4.1), the sequence of events for the task of selection of one of the input signals, measuring it with the DMM and printing the result is as follows:

1. The controller requires to select a signal and therefore must send instructions to the scanner. The instruction must not be received by the DMM or the printer and so the controller sends the general bus message 'unlisten'.

2. To enable the scanner to receive its instructions the controller sends the listen address which has been assigned uniquely to this device. It follows this with the instructions required to select a channel. The instructions are passed along the IEEE bus data lines as coded messages (bytes). The code most normally used is ASCII (American Standard Code for Information Interchange).

3. Since the scanner will take a period of time to change channels it sends a message back to the controller via one of the IEEE bus management lines (SRQ) upon completion. Note that the scanner does not have to be addressed as a talker to return information to the controller via the management lines. This is only necessary if the data lines are to be used.

4. The controller does not know which of the devices generated a message on this management line, since all devices are connected to the same line. To determine the originator, the controller will, by sending messages via the interface, ask or 'poll' all the devices either one by one (serial poll) or together (parallel poll).

5. The controller will determine that the scanner is the source and must send instructions to the DMM so that the correct range and function is selected before the measurement is made. Firstly it must ensure the scanner is not listening since any coded messages sent to the DMM (known as 'device dependent') could be misinterpreted by the scanner.

   Sending 'unlisten' followed by the listen address of the DMM and the required programming instructions achieves the desired result.

6. The DMM requires a period of time to take a measurement and prepare data. It generates a message via the same management line (SRQ) to the controller when it is ready.

7. The controller must again determine which of the devices sent the message (service request SRQ) by conducting a poll.

8. With the reading available, the controller activates the printer with its listen address only, and the DMM with its talk address.

9. When the controller signals the beginning of the transfer, using another of the bus management lines, the DMM will send the data byte

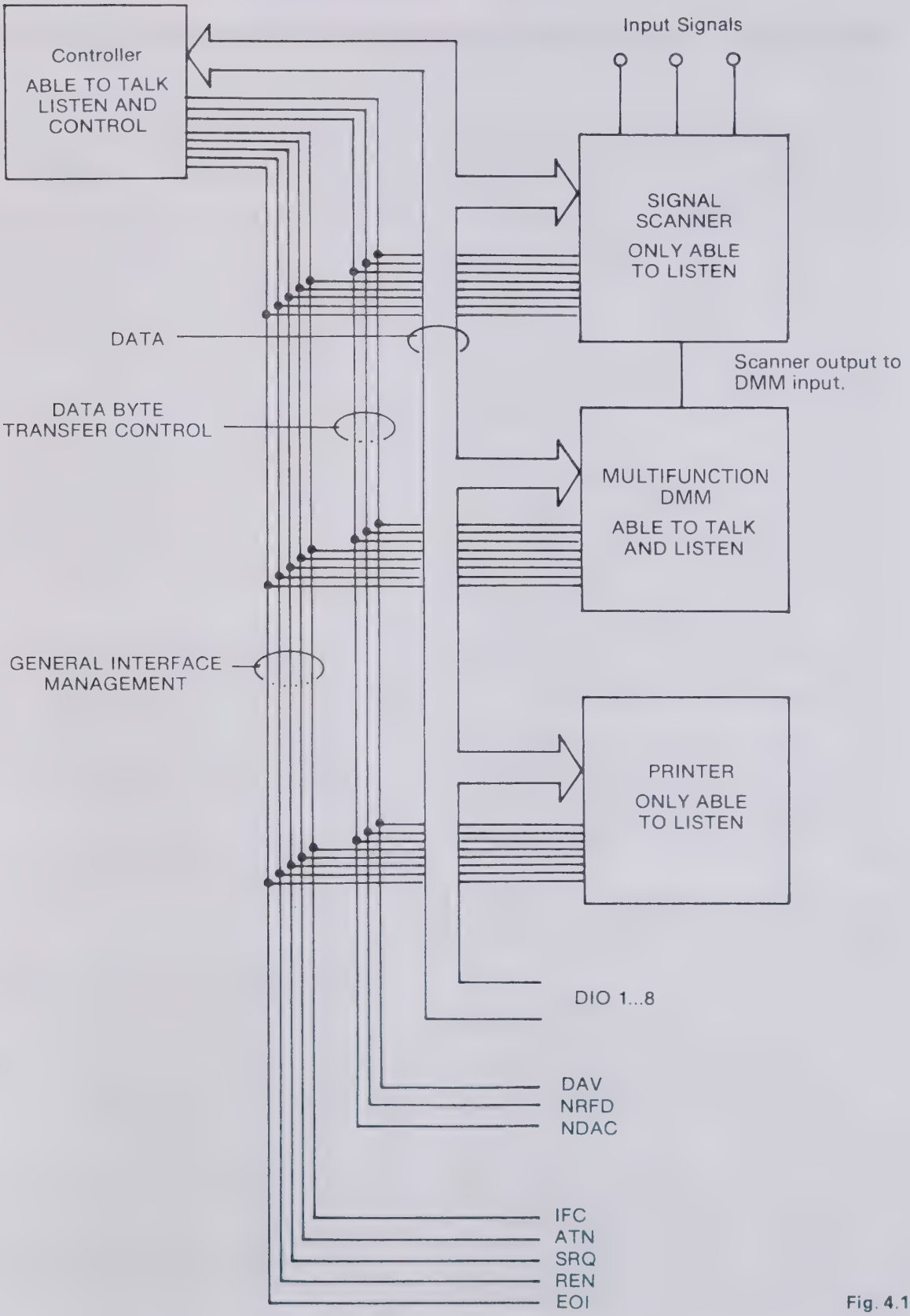

Controller
ABLE TO TALK
LISTEN AND
CONTROL
Input Signals
SIGNAL
SCANNER
ONLY ABLE
TO LISTEN
DATA
Scanner output to
DMM input.
DATA BYTE
TRANSFER CONTROL
MULTIFUNCTION
DMM
ABLE TO TALK
AND LISTEN
GENERAL INTERFACE
MANAGEMENT
PRINTER
ONLY ABLE
TO LISTEN
DIO 1...8
DAV
NRFD
NDAC
IFC
ATN
SRQ
REN
EOI

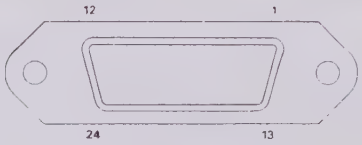
Fig. 4.1

by byte to the printer using the three data byte transfer control lines (handshake lines) to ensure orderly transfer of data between the instruments.

10. Usually the controller is also listening to this data transfer to determine when it is complete. As an aid to the controller and printer, the DMM will send with the last byte to be transferred another message (EOI end or identify) using another of the bus management lines.

11. The sequence is complete and the controller is able to start again using another input signal.

Connecting the 1081 into a system



24 - PIN SOCKET
IEEE 488/1978 INTERFACE
INPUT/OUTPUT

Fig. 4.2

J27 Pin No.	Name	Description
1	DIO 1	Data Input Output Line 1
2	DIO 2	Data Input Output Line 2
3	DIO 3	Data Input Output Line 3
4	DIO 4	Data Input Output Line 4
5	EOI	End of Identify
6	DAV	Data Valid
7	NRFD	Not ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Screening on cable - connected to DMM Safety Ground
13	DIO 5	Data Input Output Line 5
14	DIO 6	Data Input Output Line 6
15	DIO 7	Data Input Output Line 7
16	DIO 8	Data Input Output Line 8
17	REN	Remote Enable
18	GND 6	Gnd wire of twisted pair with DAV
19	GND 7	Gnd wire of twisted pair with NRFD
20	GND 8	Gnd wire of twisted pair with NDAC
21	GND 9	Gnd wire of twisted pair with IFC
22	GND 10	Gnd wire of twisted pair with SRQ
23	GND 11	Gnd wire of twisted pair with ATN
24	GND	DMM logic ground

Table 4.1 IEEE 488/1978 Connector - Pin Designations

Interconnections

Instruments fitted with an IEEE interface are connected together to form a system by using an interconnecting cable as specified in the IEEE Standard 488-1978 document. The connector and pin designations are also standardised and shown in Fig. 4.2 and Table 4.1.

Although the interface specification is called a standard, variations in implementation within the specification are permitted. These variations determine the capabilities of the particular interface and a list of abbreviations are defined in the standard document to indicate to a user which interface capabilities have been designed in. These abbreviations appear on the rear of the instrument beneath the interface connector and are shown in the table below. A fuller description of each code appears in appendix C of the IEEE standard.

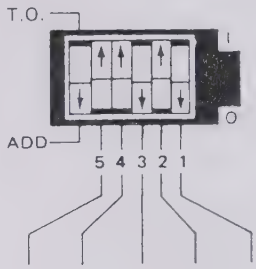
Code	Interface Function
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (basic talker, serial poll, talk only mode, unaddressed to talk if addressed to listen)
TEØ	No Address Extension Talker Mode
L4	Listener (basic listener, unaddressed to listen if addressed to talk).
LEØ	No Address Extension Listener Mode
SR1	Service Request Capability
RL2	Remote/Local Capability (without Local Lockout)
PP1	Parallel Poll Capability (configured by the controller)
DC1	Device Clear Capability
DT1	Device Trigger Capability
CØ	No Controller Capability

Table 4.2 IEEE Interface capability

Address selection

The instrument address is set manually using a six way miniature switch near the interface connector on the rear panel. Five of the switches are used to set the address, and using a binary code, this enables any address in the range 00 to 30 to be used. e.g. 11010 is address 26.

e.g. Switch setting – ADD 11010 = ADDRESS 26



A5	A4	A3	A2	A1	Decimal Code	
0	0	0	0	0	00	
0	0	0	0	1	01	
0	0	0	1	0	02	
0	0	0	1	1	03	
0	0	1	0	0	04	
0	0	1	0	1	05	
0	0	1	1	0	06	
0	0	1	1	1	07	
0	1	0	0	0	08	
0	1	0	0	1	09	
0	1	0	1	0	10	
0	1	0	1	1	11	
0	1	1	0	0	12	
0	1	1	0	1	13	
0	1	1	1	0	14	
0	1	1	1	1	15	
1	0	0	0	0	16	
1	0	0	0	1	17	
1	0	0	1	0	18	
1	0	0	1	1	19	
1	0	1	0	0	20	
1	0	1	0	1	21	
1	0	1	1	0	22	
1	0	1	1	1	23	
1	1	0	0	0	24	
1	1	0	0	1	25	
1	**1**	**0**	**1**	**0**	**26**	(e.g. above)
1	1	0	1	1	27	
1	1	1	0	0	28	
1	1	1	0	1	29	
1	1	1	1	0	30	

Table 4.3 Address Selection

'Talker only' ('T.O.')

The sixth switch, when set to a '1', causes the DMM to become a 'talker only', meaning it can only output data and not be programmed over the interface. This is particularly useful if, for example, the system consists of only a DMM (the talker) and a printer (the listener), in which case a controller is not required.

Address 31 (Illegal bus address)

If the interface option is fitted, the address selected affects the manner in which the DMM powers up.

With address 31 selected, the DMM assumes the role of bench instrument and powers up to DC, 1000V range and reading at the internally controlled read rate. In addition, a manual calibration is only enabled with Address 31 selected, as explained in the Calibration and Servicing Handbook.

With an address selected in the range of 0 to 30, the instrument powers up as a systems instrument in DC, 1000V range but in 'Hold'. Each time power-up occurs in this condition, a message is sent to the system controller to indicate that an instrument power-up has taken place.

Using the 1081 in a system

The DMM can be operated under remote control, when ASCII coded programming instructions are received from a controller, or in local control when the DMM is operated from its front/rear controls. In both cases output of results or parameters is available at both DMM display and via the interface.

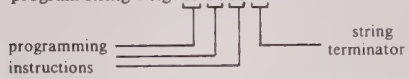
When operating in remote the legend 'rem' is displayed and all front panel controls are disabled except 'Power', '2/4-wire Ω', 'Local/Remote Guard'.

All the front panel controls (except 'Power', 2/4-wire Ω' and 'Local/Remote Guard') are programmable via the interface, in addition to 'Run/Calibration Enable' on the rear panel.

Furthermore, other 1081 features exist which are only programmable and therefore can only be used if the IEEE interface is fitted. These are known as Double trigger ratio, Double Trigger Δ, Double Trigger Δ% and Delay. These are explained in this section of the handbook under 'Programming Instructions'.

From the example given earlier in this section it may be seen that the DMM requires an address command followed by a series of device dependent messages or commands to change the various range, function and operating modes.

A series of these commands can be sent together as a 'program string'. e.g. R4F3T3 =



Each string will contain at least one programming instruction, details of which are given later, but before the instrument can take any action on the instructions, it must receive a terminate signal at the end of any string.

The required terminators are:

i) The ASCII character '='
or ii) EOI (end or identify) with the last byte of the string.

To assist in obtaining a correct set of programming instructions, the DMM checks for errors in the string, and generates a service request (SRQ) if a syntax error occurs or if an option was called for but not fitted.

The full range of commands for programming the DMM is given in Table 4.4. The precise programming details for each command are given in the next section under PROGRAMMING INSTRUCTIONS.

Programming instructions

Control of DMM inputs

Range. R1 through to R7 configure the instrument to a specific range, while R∅ places the instrument in auto-range. Programming R1 or R7 when Ohms is not selected causes the DMM to set itself to R2 and R6 respectively.

Function. F1 through to F7 configure the instrument to the required function. Programming a function which is not fitted will generate an option select error.

Filter. Programming C1 introduces an additional filter into the analog circuitry in DC, Ω or PRT; and selects 10Hz in AC.

Programming C2, C3, selects 1Hz, 0.1Hz respectively in AC, in all other functions sets C1.

Programming C∅ selects normal mode.

Front/Rear Input Selection.
Selection of front or rear can be accomplished by programming I∅—Front, I1—Signal rear, or I2—Reference rear.

Triggers. A reading may be triggered from one of three sources, (1) internally generated, (2) external (see section 3), (3) a GET (group execute trigger) via the interface. A group execute trigger is a standard bus message which is recognised by the DMM when it has been addressed as a listener. Programming the appropriate trigger code allows one or more of these sources to initiate a measurement cycle. When the DMM is programmed to accept GET, sending the ASCII character @ as part of the program string will also trigger the instrument.

The GET command will initiate a measurement cycle if one is not already in progress or will be stored until the current measurement cycle is complete in order to initiate a second cycle. This permits the second cycle to overlap the processing of data from the previous measurement cycle to increase overall instrument read rate.

In the same way, an external trigger received during the processing of data from an earlier measurement cycle will initiate another measurement cycle. External triggers received during the measurement cycle will be ignored.

CONTROL	CODE	DESCRIPTION
HIGH RESOLUTION	A∅	Normal mode
	A1	Continuous Average
	A2	Hi Res (16 reading average)
	A3	Block Average
	A4	Hi Res (4 reading average)
FILTER	C∅	Normal mode
	C1	Filter or 10Hz
	C2	1Hz
	C3	0.1Hz
DELAY	DX	Internal delay
	D***	Programmed delay (*** 0 to 254)
SPEC	E∅	Normal mode
	E1	SPEC readout mode
FUNCTION	F1	kΩ
	F2	ACV
	F3	DCV
	F4	PRT (°C readout)
	F5	PRT (Ω readout)
	F6	DC + ACV
CALIBRATE	G∅	Zero
	G1	Gain
	G2	STD
	G3	ACHF
	G4	un
INPUT SELECTION	I∅	Front
	I1	Signal (Rear)
	I2	Reference (Rear)
KEYBOARD	K	Calls Keyboard mode
STORE	L∅	Clears Limits, Max and Min stores
	L1	Store B
	L2	Store C
	L3	High Limit
	L4	Low Limit
	L5	Block Size (A3)
MESSAGE STRING	L6	K* Character String
MATHS	M∅	Normal Mode
	M1	A-B
	M2	A-C
	M3	(A-B)/C
MAX MIN	N∅	Normal Mode
	N1	Max
	N2	Min
	N3	Max-Min
OUTPUT NOTATION	O∅	Scientific and range and function
	O1	Scientific and full status
	O2	Four byte binary
	O3	As O2 without EOI
RATIO	P∅	Normal Mode
	P1	Ratio % (single trigger)
	P2	Ratio % (double trigger)
	P3	Ratio % (double trigger)
	P4	Δ (single trigger)
	P5	Δ% (single trigger)
	P6	Δ (double trigger)
	P7	Δ% (double trigger)
SERVICE REQUEST	Q∅	No SRQ generated
	Q1	SRQ when data ready for output
	Q2	SRQ if out of limit or new max min
	Q3	As Q1 with triggers inhibited until data output
	Q4	As Q2 with triggers inhibited until data output
RANGE	R∅	Autorange
	R1	10Ω otherwise 100mV,
	R2	100mV, Ω
	R3	1V, kΩ,
	R4	10V, kΩ
	R5	100mV, kΩ
	R6	1000V, kΩ
	R7	10MΩ, otherwise 1000V
TRIGGER	T∅	Internal
	T1	External
	T2	GET or @
	T3	GET, @ or external
	@	Immediate trigger
	J	Immediate trigger
RECALL STORES	V1	Store B
	V2	Store C
	V3	High Limit
	V4	Low Limit
	V5	Block Size
	V6	Message String
ENABLE CALL	W∅	Normal mode
	W1	Cal mode
SELF TEST	Y	
ZERO	Z	

Table 4.4 IEEE Programming Instructions

CONTROL	CODE	DESCRIPTION
HIGH RESOLUTION	A∅	Normal mode
	A1	Continuous Average
	A2	Hi Res (16 reading average)
	A3	Block Average
	A4	Hi Res (4 reading average)
FILTER	C∅	Normal mode
	C1	Filter on 10Hz
	C2	1Hz
	C3	0.1Hz
DELAY	DX	Internal delay
	D***	Programmed delay (*** 0 to 254)
SPEC	E∅	Normal mode
	E1	SPEC readout mode
FUNCTION	F1	kΩ
	F2	ACV
	F3	DCV
	F4	PRT (°C readout)
	F5	PRT (Ω readout)
	F6	DC + ACV
CALIBRATE	G∅	Zero
	G1	Gain
	G2	STD
	G3	AcHf
	G4	Lin
INPUT SELECTION	I∅	Front
	I1	Signal (Rear)
	I2	Reference (Rear)
KEYBOARD	K	Calls Keyboard mode
STORE	L∅	Clears Limits, Max and Min stores
	L1	Store B
	L2	Store C
	L3	High Limit
	L4	Low Limit
	L5	Block Size (A3)
MESSAGE STRING	L6	K* Character String
MATHS	M∅	Normal Mode
	M1	A-B
	M2	A/C
	M3	(A-B)/C
MAX/MIN	N∅	Normal Mode
	N1	Max
	N2	Min
	N3	Max-Min
OUTPUT NOTATION	O∅	Scientific and range and function
	O1	Scientific and full status
	O2	Four byte binary
	O3	As O2 without EOI
RATIO	P∅	Normal Mode
	P1	Ratio % (single trigger)
	P2	Ratio % (double trigger)
	P3	Ratio % (double trigger)
	P4	Δ (single trigger)
	P5	Δ% (single trigger)
	P6	Δ (double trigger)
	P7	Δ% (double trigger)
SERVICE REQUEST	Q∅	No SRQ generated
	Q1	SRQ when data ready for output
	Q2	SRQ if out of limit or new max/min
	Q3	As Q1 with triggers inhibited until data output
	Q4	As Q2 with triggers inhibited until data output
RANGE	R∅	Autorange
	R1	10Ω otherwise 100mV,
	R2	100mV, Ω
	R3	1V, kΩ
	R4	10V, kΩ
	R5	100mV, kΩ
	R6	1000V, kΩ
	R7	10MΩ, otherwise 1000V,
TRIGGER	T∅	Internal
	T1	External
	T2	GET or @
	T3	GET, @ or external
	@	} immediate trigger
	J	
RECALL STORES	V1	Store B
	V2	Store C
	V3	High Limit
	V4	Low Limit
	V5	Block Size
	V6	Message String
ENABLE CALL	W∅	Normal mode
	W1	Cal mode
SELF TEST	Y	
ZERO	Z	

Table 4.4 IEEE Programming Instructions

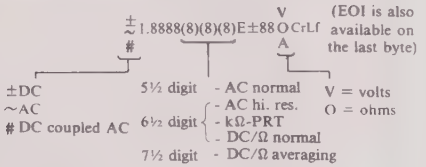
Delay. DX inserts the standard internal delay into the digital circuitry to allow for the settling of analog signals and is dependent upon the function/range/filter combination selected.

D*** (D followed by a number in the range 0-254) inserts a programmable delay.

Delay = (***N) mS
where *** is in the range 0-254
and N = 10mS

Control of DMM output

Output notation. O∅ configures the data to be output as an ASCII character string in scientific notation, with range and function data in the following format:



Programming O1 includes in the output string full instrument status information having the format:

(EOI is also available on last byte.)

NOTE: DX will be replaced by D? when using non-standard delays.

Programming O2 or O3, changes the output to four byte binary where the reading is represented as a fraction of full range. Various formats exist to cope with the variable scale lengths and the following equations are provided for translation to decimal numbers assuming the four bytes in order are A B C & D.

Positive readings (A = $\emptyset_{10}$ or 1_{10})

$$\text{Reading} = +\left(A + \frac{B}{256} + \frac{C}{65536} + \frac{D}{16777216}\right) \times \text{Full range}$$

Negative readings (A = 255_{10} or 254_{10})

$$\text{Reading} = -\left(\frac{(255-A)}{} + \frac{(255-B)}{256} + \frac{(255-C)}{65536} + \frac{(255-D)}{16777216}\right) \times \text{Full Range}$$

When output has been read no further output is available until the data from another measurement cycle has been obtained and processed. If an error occurs during a measurement cycle the normal output is replaced by a message, e.g.:

In O∅ and O1 an overload would produce 'ERR OL'.

In O2 and O3 any error will produce 255_{10}, i.e. all 1's, in all four bytes.

Service request

A wide variation can occur in the time taken for a measurement cycle, dependent on factors such as the magnitude of the signal. Therefore, when the result is available, a service request (SRQ) is generated by the DMM via the interface. This can act as a flag (or interrupt) to a controller, which is processing other data, signalling that the DMM requires service.

Q1 and Q3 allow an SRQ to be generated on completion of any reading while Q2 and Q4 allow generation of SRQ only when a reading is 'out of limits', or when a new maximum or minimum occurs. Programming Q3 or Q4 inhibits further triggers until the DMM has been serviced. An SRQ will always be generated on power up and when a syntax or option error occurs. Q∅ however, will suppress other SRQ's normally generated.

Serial Poll and Status Byte

In a system with various devices, many of them could request service and to determine which of these devices had initiated a request, either a serial poll or a parallel poll would be undertaken by the controller. During a serial poll each device sends its status byte on command, and the controller checks the request bit, thus determining a requesting device.

The DMM has many reasons for requesting service and with the additional bits available in the status byte this information is transferred at a serial poll.

Parallel poll

The parallel poll capability provided for in the DMM allows a controller with similar capability to more quickly determine which device is requesting service. The controller can at any time conduct a parallel poll, when all devices which have been configured to respond will place on separate bus data lines: a positive poll response if the device was requesting service or a negative poll response if the device does not require service. With eight data lines available the controller can simultaneously check eight responses.

Having determined the requesting devices from the parallel poll the controller would normally conduct a serial poll of these devices to determine the reason for the request.

The configuration of a device to respond to a parallel poll consists of determining the DIO line on which the response will occur, and the sense (∅ or 1) of the positive poll response. The negative poll response gives the opposite sense. The DMM can only be configured for this response by the controller. The configuration sequence is given later in this section.

The DMM **must** be serviced by either reading the output or by reprogramming to allow the generation of subsequent service requests.

To aid the user in servicing the instrument by reading, a character string is always available for output on generation of an SRQ even if a measurement is not available. This string in O∅ and O1 modes is '!CrLf' and in O2 and O3 modes all four bytes contain 255_{10} (all 1's). These 'null' strings occur with syntax or option programming errors if no measurement is available.

1 = True 0 = False x = 1 or 0

bits	b8	b7	b6	b5	b4	b3	b2	b1		
	x	0	x	x	x	x	x	x	Invalid Status byte	
	x	1	x	x	x	x	x	x	RQS Request-for-service bit	
	x	1	1	x	x	x	x	x	Syntax error	
	x	1	x	1	x	x	x	x	Option error	
Valid measurement messages										
	0	1	x	x	x	x	x	1	'Hi' limit transgressed	
	0	1	x	x	x	x	1	x	'Lo' limit transgressed	
	0	1	x	x	x	1	x	x	New maximum	
	0	1	x	x	1	x	x	x	New minimum	
	0	1	x	x	0	0	0	0	Normal reading	
Invalid measurement messages										
	1	1	x	x	0	0	0	0	Error OL	Overload/valid recall
	1	1	x	x	0	0	0	1	Error 1	Arithmetic overflow
	1	1	x	x	0	0	1	0	Error 2	Invalid data entry/invalid recall
	1	1	x	x	0	0	1	1	Error 3	Spec readout invalid
	1	1	x	x	0	1	0	0	IP·O	Input zero or calibration failure
	1	1	x	x	0	1	0	1	Error 5	DC self test failure
	1	1	x	x	0	1	1	0	Error 6	Ohms self test failure
	1	1	x	x	0	1	1	1	Error 7	AC self test failure
	1	1	x	x	1	0	0	1	Error 9	Arithmetic underflow
	1	1	x	x	1	0	1	1		Reference finished (see code P2)
	1	1	x	x	1	1	0	0	Fail	Self test finished memory fail
	1	1	x	x	1	1	0	1	Pass	Self test finished memory pass
	1	1	x	x	1	1	1	0		Power-up/memory fail
	1	1	x	x	1	1	1	1		Power-up/memory pass

Table 4.5 Status Byte Coding

Control and computing functions

Keyboard. The DMM will place itself into keyboard mode on receipt of a K, enabling the entry of math, limit and calibration constants via the bus. The constant may be expressed in numeric or scientific notation as ±1.999999(9) E±∅9. If a two digit exponent is used the first must be zero. To exit keyboard mode the constant entered must be placed in an appropriate store or used in calibration.

NOTE: The constant entered in not shown on the front panel display.

Store. L1 through to L4 inform the instrument of the store location for the entered constant or alternatively, if used without keyboard mode, the location for the previous valid reading.

L∅ deselects limit operations and resets max/min stores. A new max/min value will be stored on completion of the next valid reading.

Store L5 is only accessible after A3 is programmed
i.e.: A3, L5, N1----19,999
sets new block size on 1----19,999

Store L6 is only accessible in calibrate mode and after selecting keyboard.
i.e. K* character string L6

This store can be used to store a message using 0–9 and decimal point to a maximum of 8 digits.
e.g. Date of next calibration 01.02.84.

Recall stores. The current contents of the stores can be displayed on the front panel and output via the bus with the commands V1 through to V4 having the format:

±1.999999(9)E±99L2CrLf.
└── store location

NOTE:
1. The output of the stores is not available in binary output modes.
2. It is recommended that after the recall of a store value the trigger mode is reprogrammed.
3. Recall of empty limit stores will result in ERR 2 being output.

Recall store V5 recalls block size but does not display block size unless preceded by A3. i.e. A3V5.

Recall store V6 recalls message String.

Maths mode. Programming M1 to M3 causes the reading to be offset, divided by or both offset and divided by the contents of stores B and C respectively. M∅ places the instrument back to its normal operating mode.

Max/min. The maximum or minimum reading since the stores were last reset is output in place of the current reading when N1 or N2 are programmed. N3 computes the difference between maximum and minimum. N∅ places the instrument back to its normal operating mode. Reset of stores occurs automatically on changing function and entry or exit from ratio and programming L∅ mode.

Ratio. Programming rear input with P1 or P2 configures the DMM into the ratio mode. P1 when next triggered initiates two readings, the first from the reference input and the second from the rear signal input. P2, P3, P6 and P7 require two triggers, the first to take a reading from the reference input (an SRQ being generated on completion) and the second, a reading from the rear signal input. The ratio is then calculated and made available for output as a 'per unit' (p.u.) quantity, the format being:

±1.999999(9)E±99PUCrLf

High resolution

Programming A∅–A4 selects one of the following modes:

A∅ - Normal mode
A1 - Continuous average
A2 - High resolution mode
A3 - Block average
A4 - Filter average (Block of 4)

If no block size has been inserted a block size of 1 is recorded.

If block size of ∅ is inserted in manual a block size of 1 is recorded.

Calibration via the bus

The DMM can be calibrated remotely using the programming instructions provided. For full details of procedure see the Calibration and Servicing Handbook.

Invalid use of these instructions will cause the generation of an option error SRQ.

Spec readout, test and input zero

Spec. The programming and execution of code E1 causes the instrument to compute the measurement uncertainty of the previous reading. An SRQ is generated (if allowed) with the status byte indicating a normal valid measurement. The output format is:

1.888E±PUCrLf (where PU = per unit)

The DMM will be held until E∅ is programmed or until a GET, J, or @ is received, assuming the correct trigger mode has been programmed.

Spec readout is not available for maths modes.

Self test. When the DMM receives a Y command the internal test routine is initiated. The front panel displays are not exercised in this test and only option and calibration memory checks are included. Any error will be reported with the generation of an SRQ together with the appropriate status and an error message made available for output. An @ or J (regardless of trigger mode programmed) will continue the test after an error situation. Upon completion an appropriate pass or fail status will be generated with an SRQ, and the DMM will return to the previously programmed range and function. Maths modes, max/min, Hi Res and Spec readout will all be cleared on completion.

Input zero. Z initiates a series of 17 readings at an internal read rate, the first 16 being averaged and the result used as a zero offset. The 17th reading is available for output. If autorange is selected each range is zeroed in turn (lowest to highest). Should the offset be too large, the store is not updated and an SRQ and error status is generated together with an error message for output.

Program string characteristics

If more than 25 bytes have been programmed before receipt of any terminator the execution of the string will commence sequentially until sufficient space is available for further input data.

If an invalid command is sent an SRQ will be generated, the associated status byte containing a syntax or option error. In this case the output available is '!CrLf'.

NOTE: 1. For program instruction requiring only one numeral after an alpha character, the last numeral is operated on and a syntax error reported.
e.g. F123 results in F3 (DCV).

2. For all program strings a finite time is required for execution, e.g. the string 'R4F3Q1T7=' will be processed and triggers enabled after approx 15mS from receipt of string terminator.

Bus messages

Remote. The DMM will go into remote when remote enable line (REN) is true and the device receives its listen address. It is possible to send a program string to the DMM when in local which will be acted upon immediately when the DMM goes to remote.

Local. The GTL message returns the DMM to front panel control in the condition in which it was last programmed remotely with the exception of the trigger mode which is forced to L T3 except T∅ which remains at T∅.

Clear. When the instrument receives a clear message (SDC or DCL) it will revert to a predetermined state of DC volts 1000V range and hold.

i.e. AØCØDXEØF3MØNØPØQØR6SØT1

Operational sequence guidelines

Most interface communication tasks require sequences of coded messages to be sent over the interface. Many controllers assign a single programming instruction to a complete sequence, so it is advisable to study the available controller capabilities carefully before attempting to program a system. Because the IEEE Std 488 (1978) allows a certain latitude in bus protocol, considerable differences may be found between programming instructions and operating sequences from one make of controller to another.

Consequently, the following sequences are recommendations only.

Untalk

It is highly recommended that a sequence which causes the DMM to be addressed as a talker should be terminated with an untalk command.

Data transfer

UNL	Inhibits all current listeners
LAD_1 ⋮ LAD_n	Each address sent enables a specific device to receive future data bytes. More than one address may be sent if multiple listeners desired.
TAD	The address sent enables a specific device to send data.
DAB_1 ⋮ DAB_n	Data bytes sent by currently enabled talker to all currently enabled listeners.
UNT	Disables the talker on receipt of last character.

UNL =	unlisten
LAD =	listen address of specific device
TAD =	talk address of specific device
DAB =	data bytes
UNT =	untalk

Serial poll

UNL	Prevents other devices listening to status sent.
SPE	Puts interface into serial poll mode during which all devices send status instead of data when addressed.
TAD_n	Enable a specific device to send status. Within this loop devices should be sequentially enabled.
SBN or SBA	Status byte sent by enabled device. If SBN sent, loop should be repeated. If SBA sent, the enabled device is identified as having sent SRQ and will automatically remove it.
SPD	Disables serial poll mode
UNT	Disable last talker.

SPE =	serial poll enable
SPD =	serial poll disable
SBN =	status byte negative where bit 7 = ∅
SBA =	status byte affirmative where bit 7 = 1.

Parallel poll Configure

LAD	Addresses a particular device for which a parallel response coding is to be assigned.
PPC	Enables the listener to be configured.
PPE	Bit 4 specifies the sense of the poll response. Bits 1 to 3 specify, in binary code, the data line (DIO) on which the poll response is to be given.
UNL	End of configuration routine.

PPC =	parallel poll configure
PPE =	parallel poll enable

NOTE: The PPE command can be disabled by substitution of PPD.
All devices can be unconfigured by use of the PPU command.

PPD =	parallel poll disable
PPU =	parallel poll unconfigure

Parallel poll response

To obtain the parallel poll response, the controller must place the management lines ATN and EOI (attention and identify) true when the predetermined devices will each place their request on a specified data line.

SECTION 5 INSTALLATION

This section contains information and instructions for unpacking and installing the Datron 1081 Autocal Multimeter.

Unpacking and inspection

Every care is taken in the choice of packing material to ensure that your equipment will reach you in perfect condition.

If the equipment has been subject to excessive mishandling in transit, the fact will probably be visible as external damage to the shipping carton. In the event of damage, the shipping container and cushioning material should be kept for the carrier's inspection or until the instrument has passed the Specification Verification Tests.

Unpack the equipment and check for external damage to the case, terminals, keys, etc. If damage is found notify the carrier and your sales agent immediately.

Standard accessories supplied with the instrument are as described in Section 1. If input and/or output options are fitted the appropriate plug or socket is attached in its respective place on the rear panel of the instrument.

The rack mounting kit option is packed separately and should be fitted as instructed in 'mounting'.

Preparation for operation

Power cable

A detachable supply cable, comprising two metres of 3-core PVC sheath cable permanently moulded to a fully-shrouded 3-pin cable socket, fits at the rear of the instrument and should be pushed firmly home. The supply lead should be connected to grounded outlet ensuring that the ground lead is connected. Connect Brown lead to Live, Blue lead to Neutral and Green/Yellow lead to Ground.

Line voltage

The instrument is packed ready for use with 205V to 255V 50Hz supplies unless Option 80, 81 or 82 is specified at the time of ordering. To change the supplies and/or line frequency, it is essential to alter links in the instrument. (Refer to Calibration and Servicing Handbook.)

Fuses

Power Fuse:
The power fuse is located on the left-hand side of the back panel adjacent to the power input. The power fuse rating is 160mA for 205V—255V and 500mA for 105V—127V supply voltages. It should be of the anti-surge type.

MAKE SURE THAT ONLY FUSES WITH THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE ARE USED FOR REPLACEMENT. THE USE OF MENDED FUSES AND THE SHORT-CIRCUITING OF FUSE-HOLDERS SHALL BE AVOIDED, AND RENDERS THE WARRANTY VOID.

Mounting

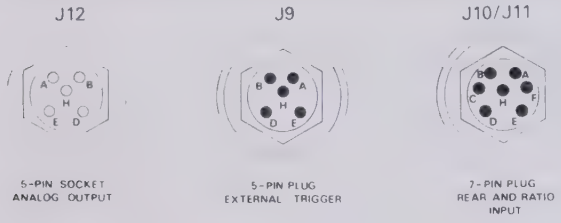
Bench Use:
The instrument is fitted with rubber covered plastic feet and tilt stand. Thus it may be placed flat on the bench or tilted for ease of viewing.

Rack Mounting:
Option 90 permits the instrument to be mounted in a standard 19 inch rack.

The method of fitting this option is described below but on no account should the covers be removed. The handles should be removed, if fitted, by loosening the hexagonal screws of the handle assembly and sliding the assembly to the rear of the instrument until free.

The rack mounting 'ears' may now be fitted by slotting the 'ears' into the guides at each side of the instrument, from the rear. Draw the 'ears' forward until positioned correctly and tighten the hexagonal screws, using the hexagonal key provided. It is recommended that the rear of the instrument is supported in the rack.

Connectors and pin designations



Rear input and ratio input (option 40)

J10 and J11 are 7-pin connectors accepting input signals as defined for the front panel terminals. See Tables 2.1 to 2.3 for maximum inputs, Table 5.1 for pin descriptions and Fig. 5.1 for pin layout.

Pin No.	Signal
A	Ω GUARD
B	Not Used
C	I+
D	Input Hi
E	Input Lo
F	I–
H	GUARD

Table 5.1 Ratio & Rear Inputs - pin designations

NOTE: For local guarding, connect pins A and H.

External trigger input (option 52)

J9 is a 5-pin connector used to accept an external trigger source to initiate a DMM measurement cycle. See Table 5.2 for pin descriptions and Fig. 5.1 for pin layout.

Pin No.	Signal
A	Trigger (High to Lo edge ↓)
B	Logic Ground
D	Not Used
E	Not Used
H	Not Used

Table 5.2 External Trigger Input - pin designations

Analog output (option 70)

J12 is a 5-pin connector providing a 1V full-range output for any nominal full-range input, with over-range capability to 2V. See Table 5.3 for pin designations and Fig. 5.1 for pin layout.

Pin No.	Signal
A	Output Hi
B	Output Lo
D	)
E	) Not Used
H	)

Table 5.3 Analog Output - pin designations

IEEE input/output (option 50)

The IEEE input/output is a 24-way connector that is directly compatible with the IEEE defined system.

Fig. 5.2 gives the pin designations and Table 5.4 the pin layout.

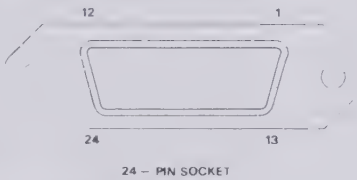


Fig. 5.2 IEEE 488 connector - pin layout

J27 Pin No.	Name	Description
1	DIO 1	Data Input Output Line 1
2	DIO 2	Data Input Output Line 2
3	DIO 3	Data Input Output Line 3
4	DIO 4	Data Input Output Line 4
5	EOI	End or Identify
6	DAV	Data Valid
7	NRFD	Not ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Screening on cable - connected to DMM Safety Ground
13	DIO 5	Data Input Output Line 5
14	DIO 6	Data Input Output Line 6
15	DIO 7	Data Input Output Line 7
16	DIO 8	Data Input Output Line 8
17	REN	Remote Enable
18	GND 6	Gnd wire of twisted pair with DAV
19	GND 7	Gnd wire of twisted pair with NRFD
20	GND 8	Gnd wire of twisted pair with NDAC
21	GND 9	Gnd wire of twisted pair with IFC
22	GND 10	Gnd wire of twisted pair with SRQ
23	GND 11	Gnd wire of twisted pair with ATN
24	GND	DMM logic ground

Table 5.4 IEEE 488 connector - pin designations

SECTION 6 SPECIFICATIONS

General

POWER SUPPLY

Voltage	:	105-127 or 205-255 Volts
Line Frequency	:	50Hz±2%, 60Hz±2%, or 400Hz±2%
Consumption	:	Approximately 20 Watts
Fuses	:	160mA or 500mA anti-surge (depends on voltage)

MECHANICAL

Dimensions	:	Height = 89mm (3.5ins) Width = 455mm (17.9ins) Depth = 420mm (16.5ins)
Weight	:	10 kg (22lbs)

AUTORANGE

Range Up	:	200% of nominal range
Range Down	:	18.8% of nominal range

SAFETY

The 1081 has been designed to meet BSI 4743, IEC 348, and UL 1244 specifications.

Read rate	:	with full scale input 2/second

CLIMATIC CONDITIONS

Operating Temperature	:	0°C to +50°C (except where specified)
Storage Temperature[1]	:	−40°C to +70°C
Maximum Relative Humidity	:	75% @ 40°C
Warm-up Time	:	Two hours to meet all specifications

OPERATING INDICATIONS

Scale length	:	7½ digits maximum, i.e. 19,999,999
Overload	:	Error 0L displayed
indication	:	Symbols lit on display and illuminated keys

DIGITAL ERROR

Computation	:	±1 digit (assumes no error in stored value)
Spec read-out	:	< 1% of displayed SPEC

MAXIMUM INPUTS

See Tables 2.1 and 2.2 on page 2.1

ANALOG OUTPUT (0 to ±2 Volts)

1 Volt output for full range signal input

Accuracy	:	±1% of Reading ±2mV
Output Resistance	:	Approximately 200Ω

[1] Excessive temperature stress may affect calibration stability.

Stability and Accuracy

RANGES	STABILITY [2] ±(ppm Reading + ppm FS) [4]		ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(ppm Reading + ppm FS) [4][8] 23°C±1°C			ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(ppm Reading + ppm FS) [4][8] 23°C±5°C		
	1 Minute	24 Hours	24 Hours	90 Days	1 Year	24 Hours	90 Days	1 Year
100.0000(0)mV	0.25 + 0.25μV	2.0 + 1.50	3 + 2.0	8 + 2.0	11 + 2.0	8 + 2.0	11 + 2.0	14 + 2.5
1.000000(0)V	0.25 + 0.5μV	1.5 + 0.25	2 + 1.0	5 + 1.5	8 + 1.5	5 + 1.5	8 + 1.5	11 + 1.5
10.00000(0)V	0.25 + 2.5μV	1.5 + 0.25	2 + 0.5	5 + 1.0	8 + 1.0	5 + 1.0	8 + 1.0	11 + 1.5
100.0000(0)V	0.25 + 50μV	2.0 + 0.25	3 + 1.0	8 + 1.5	11 + 1.5	8 + 1.5	11 + 1.5	14 + 1.5
1000.000(0)V	0.25 + 250μV	2.0 + 0.25	3 + 1.0	8 + 1.5	11 + 1.5	8 + 1.5	11 + 1.5	14 + 1.5

NOTES:
( ) – Hi Res selected gives 7½ digits on DCV and Resistance; 6½ digits on ACV.
[1] – signals $< 2 \times 10^7$ Volt-Hertz $> 1\%$FS: DC coupled below 100Hz.
[2] – For same conditions with Hi Res selected between 18°C and 28°C.
[3] – Datron Instruments traceability to National Standards.
[4] – FS = 2 × Full Range.
[5] – At same amplitude, frequency etc., errors tend to zero.
[6] – Add 0.01% per 100V above 500V.
[7] – At full range ±2%.
[8] – Figures assume prior Input Zero.

CALIBRATION UNCERTAINTY ±ppm [3]	TEMPERATURE COEFFICIENT ±ppm Reading per °C 13°C – 18°C 28°C – 33°C	NOISE Filter (Hi-Res) selected and after 'Zero' Peak over 1 min. ±ppm Reading	INPUT IMPEDANCE
5	1.5	0.15 + 0.2μV	.1 to 10V ranges,
3	1.0	0.15 + 0.3μV	(<20V):
3	1.0	0.15 + 2.0μV	>10,000MΩ
5	1.5	0.15 + 30μV	100&1000V ranges:
5	1.5	0.15 + 200μV	10MΩ±0.1%

Other Specifications

Type:	Multi-slope A-D Converter.
Read Rate:	2 Readings per second.
Full Scale Count:	1,999,999(9) on all ranges except 1000V.
Normal Mode Rejection Ratio	
Filter Out:	66dB at 50/60Hz±0.15%.
Filter In:	120dB at 50Hz increasing at 18dB per octave.
Common Mode Rejection Ratio (1kΩ Source Unbalance)	
DC:	>140dB.
1Hz – 60Hz:	80dB plus Normal Mode Rejection.
Settling Time: (to within 10ppm of step size)	
Filter Out:	<50ms.
Filter In:	<1s (<3s in LOCAL operation).
Input Current:	<50pA drifting at <1pA per °C.
Input Protection:	Withstands 1000V RMS on any range.
Zero Temperature Coefficient:	1/10 of 'FS' part of 90-day specification, per°C.
Zero Stability:	(±(0.2 digits±0.1μV) per month).
Ratio Accuracy [5]:	±net signal accuracy±net reference accuracy.

AC Voltage

True RMS [1]

Stability and Accuracy

Resolution	RANGE Frequencies	Ranges	STABILITY [2] ±(ppm Reading + ppm FS) [4] 1 Minute	STABILITY [2] ±(ppm Reading + ppm FS) [4] 24 Hours	ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(% Reading + % FS) [4] 23°C±1°C 24 Hours	ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(% Reading + % FS) [4] 23°C±1°C 90 Days	ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(% Reading + % FS) [4] 23°C±1°C 1 Year
100.000(0)mV	10Hz-2kHz	100mV	10 + 5.0	40 + 15	0.02 + 0.007	0.025 + 0.007	0.03 + 0.007
1.00000(0)V		1V-100V	10 + 2.5	30 + 8	0.01 + 0.005	0.015 + 0.005	0.02 + 0.005
10.0000(0)V		1kV	20 + 2.5	50 + 8	0.02 + 0.007	0.025 + 0.007	0.03 + 0.007
100.000(0)V							
1000.00(0)V							
	2kHz-20kHz	100mV	10 + 5.0	60 + 20	0.04 + 0.012	0.060 + 0.012	0.08 + 0.012
		1V-100V	10 + 2.5	50 + 12	0.02 + 0.010	0.030 + 0.010	0.04 + 0.010
		1kV [6]	20 + 2.5	70 + 12	0.04 + 0.012	0.060 + 0.012	0.08 + 0.012
	20kHz-100kHz	100mV	10 + 5.0	70 + 30	0.08 + 0.022	0.120 + 0.022	0.16 + 0.022
		1V-100V	10 + 2.5	60 + 25	0.04 + 0.020	0.070 + 0.020	0.10 + 0.020
		1kV [6]	20 + 2.5	80 + 25	0.08 + 0.022	0.120 + 0.022	0.16 + 0.022

AC Voltage Transfer

(6½ digits) Frequencies	Ranges	TRANSFER STABILITY (±% Reading) [2][7] AC/DC 24 Hours 23°C±1°C	AC/DC 90 Days 23°C±5°C	AC/AC 24 Hours 23°C±1°C	ACV/DCV TRANSFER ACCURACY (±% add to Transfer Stability)
10Hz-2kHz	100mV	0.005	0.010	0.004	0.02
	1V-100V	0.003	0.005	0.003	0.01
	1kV	0.005	0.010	0.005	0.02
2kHz-20kHz	100mV	0.010	0.040	0.006	0.06
	1V-100V	0.005	0.015	0.005	0.03
	1kV [6]	0.010	0.040	0.007	0.06 [6]

NOTES:

( ) – Hi Res selected gives 7½ digits on DCV and Resistance; 6½ digits on ACV.

[1] – Signals $< 2 \times 10^7$ Volt-Hertz $> 1\%$ FS: DC coupled below 100Hz.

[2] – For same conditions with Hi Res selected between 18°C and 28°C.

[3] – Datron Instruments traceability to National Standards.

[4] – FS = 2 × Full Range.

[5] – At same amplitude, frequency etc., errors tend to zero.

[6] – Add 0.01% per 100V above 500V.

[7] – At Full Range±2%.

ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(% Reading + % FS) [4] 23°C±5°C			CALIBRATION UNCERTAINTY ±ppm [3]	TEMPERATURE COEFFICIENT ±ppm Reading per °C 13°C-18°C 28°C-33°C	NOISE 1Hz LF filter and Hi Res selected. Peak over 1 Min. ±% Reading	INPUT IMPEDANCE
24 Hours	90 Days	1 Year				
0.025 + 0.007	0.030 + 0.007	0.040 + 0.007	100	15	0.001± 10 digits	1MΩ shunted by 150pF
0.015 + 0.005	0.020 + 0.005	0.025 + 0.005	50	15	0.001± 5 digits	
0.025 + 0.007	0.030 + 0.007	0.040 + 0.007	100	15	0.002± 5 digits	
0.060 + 0.012	0.090 + 0.012	0.110 + 0.012	100	25	0.001± 5 digits	
0.030 + 0.010	0.045 + 0.010	0.055 + 0.010	50	25	0.001± 5 digits	
0.060 + 0.012	0.090 + 0.012	0.110 + 0.012	100	25	0.002± 5 digits	
0.120 + 0.022	0.180 + 0.022	0.230 + 0.022	200	100	0.001± 5 digits	
0.080 + 0.020	0.090 + 0.020	0.140 + 0.020	100	100	0.001± 5 digits	
0.120 + 0.022	0.180 + 0.022	0.230 + 0.022	200	100	0.002± 5 digits	

Other Specifications

Type: True RMS AC-coupled measures AC component with up to 1000V DC bias on any range.
By pressing AC and DC keys, DC-coupled true RMS AC is measured, i.e. $\sqrt{AC^2+DC^2}$.

Read Rate:	2 Readings per second.
Full Scale Count:	199,999(9) on all ranges except 1000V.
Crest Factor:	5:1 at Full Range.
Common Mode Rejection Ratio:	(1kΩ source unbalance).
DC-60Hz:	>90dB.
Settling Time in Local Operation	(to within 0.1% of step size).
100Hz:	<500ms.
10Hz:	<2.5s.
1Hz:	<15s.
0.1Hz:	<150s.
Input Protection:	Withstands 1000V RMS on any range.
Ratio Accuracy [5]:	±net signal accuracy±net reference accuracy.
Add to the main Accuracy Specifications for:	
DC signals:	0.01% Reading±0.0015% FS±10μV.
LF 0.1Hz:	As DC signals±0.05% FS.
LF 1Hz:	As DC signals±0.01% FS.
LF 10Hz:	As main Accuracy specification.
HF 100kHz-1MHz:	2% Reading±1% FS (1V and 10V ranges).

Stability and Accuracy

RANGES	STABILITY [2] ±(ppm Reading + ppm FS) [4]		ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(ppm Reading + ppm FS) [4] 23°C±1°C			ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(ppm Reading + ppm FS) [4] 23°C±5°C		
	1 Minute	24 Hours	24 Hours	90 Days	1 Year	24 Hours	90 Days	1 Year
10.00000(0)Ω	0.5 + 50μΩ	2.5 + 2.5	4 + 3	7 + 3.0	12 + 3.0	10 + 3.0	15 + 3.5	20 + 4
100.0000(0)Ω	0.5 + 60μΩ	2.0 + 0.5	3 + 1	5 + 1.5	10 + 1.5	7 + 1.5	10 + 1.5	15 + 2
1.000000(0)kΩ	0.5 + 600μΩ	2.0 + 0.5	3 + 1	5 + 1.5	10 + 1.5	7 + 1.5	10 + 1.5	15 + 2
10.00000(0)kΩ	0.5 + 6mΩ	2.0 + 0.5	3 + 1	5 + 1.5	10 + 1.5	7 + 1.5	10 + 1.5	15 + 2
100.0000(0)lΩ	0.5 + 60mΩ	2.5 + 0.5	4 + 1	6 + 1.5	11 + 1.5	8 + 1.5	10 + 1.5	15 + 2
1000.000(0)kΩ	1.0 + 500mΩ	4.0 + 0.5	7 + 1	15 + 1.5	25 + 1.5	15 + 1.5	25 + 1.5	35 + 2
10,00000(0)MΩ	5.0 + 5Ω	6.0 + 0.5	10 + 1	30 + 1.5	50 + 1.5	20 + 1.5	40 + 1.5	60 + 2

NOTES:

[ ] – Hi Res selected gives 7½ digits on DCV and Resistance; 6½ digits on ACV.
[1] – Signals $<2\times10^7$ Volt-Hertz $>$ 1% FS: DC coupled below 100Hz.
[2] – For same conditions with Hi Res selected between 18°C and 28°C.
[3] – Datron Instruments traceability to National Standards.
[4] – FS = 2 × Full Range.
[5] – At same amplitude, frequency etc., errors tend to zero.
[6] – Add 0.01% per 100V above 500V.
[7] – At Full Range ±2%.

CALIBRATION UNCERTAINTY ±ppm [3]	TEMPERATURE COEFFICIENT ±ppm Reading per °C 13°C-18°C 28°C-33°C	NOISE Filter (Hi-Res) selected, and after 'Zero' Peak over 1 min. ±ppm Reading	MEASUREMENT CONSTANT-CURRENT VALUE (I+ to I−)
5	1.5	0.25 + 30μΩ	10mA
5	1.0	0.25 + 50μΩ	10mA (1mA-PRT)
5	1.0	0.25 + 500μΩ	1mA
5	1.0	0.25 + 5mΩ	100μA
10	1.0	0.25 + 50mΩ	10μA
15	2.0	0.50 + 500mΩ	5μA
20	2.5	0.50 + 5Ω	500nA

Other Specifications

Type: True 4-wire can be switched to 2-wire from Front Panel.
Active Guard allows in-circuit measurements (Refer to pages 2-7).

Read Rate:	2 Readings per second.
Full Scale Count:	1,999,999(9) on all ranges.
Settling Time:	Up to 10kΩ range; generally the same as DCV but depends on external capacitances and guarding/shielding techniques employed.
Open-circuit Voltage:	<20V all ranges.
Lead Resistance:	Up to 100Ω.
Input Protection:	Withstands 250V RMS on any range.
Ratio Accuracy [5]:	±net signal accuracy±net reference accuracy.

Temperature

Probe immersion using PRT 100 accessory: 100mm

RANGE	ABSOLUTE ACCURACY (± °C)			CALIBRATION UNCERTAINTY Included in 90 day and 1 year accuracy specifications (± °C)
°C display (5½ digits)	23°C ± 1°C 24 Hours	23°C ± °C 90 Days	23°C ± 5°C 1 Year	
– 100 to – 55	0.20	0.25	0.30	0.002 at 0°C 0.01 at 100°C
– 55 to 0	0.04	0.10	0.15	
0 to + 100	0.02	0.06	0.10	
+ 100 to + 200	0.04	0.10	0.15	
At 0°C & + 100°C	0.01	0.05	0.08	

Ω display (6½ / 7½ digits)	ACCURACY RELATIVE TO CALIBRATION STANDARDS ± (ppm reading + ppm FS)		
100Ω(1mA)	3 + 3	10 + 3.5	15 + 4

Ratio

Normal Ratio Input Conditions: any input on any range

Accuracy:

$$\pm E_R \pm E_S \pm X. \left(\left| \frac{\text{Ref. range}}{\text{Ref. reading}} \right| + \left| \frac{\text{Sig range}}{\text{Sig reading}} \right| \right)$$

Where E_R = Net error of reference
E_S = Net error of signal
settling factor X = 0.000 002 (DCV, kΩ)
= 0.000 02 (ACV)

Time per reading (Full Scale input, Hi Res deselected):

FUNCTION	FILTER out	FILTER in
DCV: 100mV	5.6 s	47.5 s
1V-1kV	3.4 s	47.5 s
ACV	4.6 s	12 s (10Hz), 58 s (1Hz), 600 s (0.1Hz)
kΩ: 10Ω	5.6 s	47.5 s
100Ω-100kΩ	3.4 s	47.5 s
1MΩ	3.4 s	48 s
10MΩ	3.9 s	50 s

Transfer

Transfer Input Conditions: same Function, Range & Polarity,
Signal and Reference input amplitude both within ±2% of Full Range,
'Hi Res' selected and after 'Zero' on both inputs,
same Signal & Reference frequency on ACV (except ACV/DCV)

Accuracy: DCV/DCV: as DC Voltage, Stability, 24 hr specification
ACV/ACV: as AC Voltage, Transfer Stability, 24 hr specification
ACV/DCV: shown on AC Voltage, Transfer Accuracy table
kΩ/kΩ: as Resistance, Stability, 24 hr specification

Time per reading (Full Scale input, Hi Res selected: as Ratio specification

Standard internal delays

Between the receipt of any trigger pulse and the commencement of a measurement cycle, an internal time delay is introduced.

This permits the application of the signal to the input terminals to be coincident with the trigger and ensures that the input circuitry has settled before the commencement of the reading cycle.

The standard internal delays differ for each range and function in order to ensure maximum read-rate and adequate settling. The delays are shown in the following table:

		FILTER (ms)			
		OUT	IN		
Function	Range	100Hz	10Hz	1Hz	0.1Hz
DCV	all	50		1000	
ACV DC + ACV	all	1s	4s	20s	200s
kΩ	10Ω-100kΩ	50		1000	
	1MΩ	50		1200	
	10MΩ	310		2500	

Additional to all the delays shown above is 25ms when changing range between the 10V and 100V ranges and 100ms before the first reading following a function change.

'Spec' Readout Validity

DC Voltage & Resistance — valid for all ranges
AC Voltage — valid for all inputs except: – DC coupled signals <10Hz
– HF signals >100kHz

Temperature — no readout for °C display
valid for Ω display

Ratio — for normal Ratio, readout is $\pm E_R \pm E_S$
for Transfer, readout $\pm E_R$ for 24 hr accuracy
where E_R = Net error of reference
E_S = Net error of signal

SECTION 7 SPECIFICATION VERIFICATION

Introduction

This section contains procedures which check that the instrument is working within its specified traceable accuracy. In addition, functions of the COMPUTE and KEYBOARD facilities can be checked by following the examples in Section 3.

To record the readings obtained, a Specification Verification Report Sheet is included at the end of the section. This can form a permanent record, and may be used to check the instrument on receipt from Datron, or for a periodic performance test. The sheet may be used as a master to generate duplicate copies for future use.

1081 Specifications

The specifications appearing in Section 6 are deliberately arranged to take separate account of each contributing uncertainty. In particular, Datron's calibration uncertainty figures are not included in any of the other specifications, but are given in a separate table. This means that the stability and accuracy specifications describe the true performance of the instrument alone, in a form which can be made traceable to National Standards merely by adding in the uncertainty of the reference standard against which it is checked or calibrated.

Thus the 24-Hour, 90-day or 1-year accuracy specifications are verifiable by comparison with traceable Reference Standards.

The 1-min and 24-hour stability specifications can only be verified following a calibration operation or calibration check, under the same conditions, against the user's Reference Standards.

Use of 'Spec' Mode

The verification procedures in this section are written to take advantage of the 'Spec' mode facilities built into the instrument, because many users will wish to verify the 1081 at values other than Cardinal points (e.g. at standard-cell derived values). Also, in view of the need to include both the factory AND/OR user's uncertainties in the verification tolerances, a fixed table of limits would be inappropriate. Instead of limit tables, the Report Sheet at the end of this Section includes columns for recording the 'Spec' mode readout, the factory and user's uncertainties, the calculated limits, and the measured values.

Stored Specifications

Three specifications are stored within each instrument's non-volatile memory. They are accessible to users by selecting 'Spec' mode (Refer to Section 3), and are selectable by the CALIBRATION INTERVAL switch on the rear panel. The displayed figures are compiled from the Section 6 tables as follows:

a. 24hr CALIBRATION INTERVAL
   23°C±1°C, 24 Hours Relative Accuracy figure.

b. 90dy CALIBRATION INTERVAL
   23°C±5°C, 90 Days Relative Accuracy figure, plus Datron's Calibration Uncertainty.

c. 1yr CALIBRATION INTERVAL
   23°C±5°C, 1 Year Relative Accuracy figure, plus Datron's Calibration Uncertainty.

Spec mode therefore provides 90 day and 1 year accuracy figures which are traceable through Datron standards to National Standards, for users who have no calibration or verification facilities of their own.

N.B. The figures do not include temperature-coefficient corrections for ambient temperatures outside the specified range. These should be taken into account if appropriate.

Non-Verification

If an instrument is found to be out of specification, refer to the Routine Autocalibration in the Calibration and Servicing Handbook, or contact your nearest Datron Servicing Center.

Equipment Requirements

The following equipment, or equipment of suitable traceable accuracy over the range of values given, is required to verify the traceable accuracy of the 1081.

DC voltage (±10mV – ±1000V)
- Datron 4000 or 4000A Autocal Standard.

AC Voltage (100mV – 500V: 200Hz, 3kHz, and 30kHz)
- Datron 4200, or Fluke 5200 and 5215.

Resistance (4-wire: 10Ω, 100Ω, 1kΩ, 10kΩ; and 2 or 4-wire: 100kΩ, 1MΩ, 10MΩ.)
- Datron 4000 or 4000A Autocal Standard.

Verification upon receipt of a 1081 Standards Multimeter

Each instrument is factory-calibrated and verified by Quality Control to a higher traceable accuracy than its published specification. The limits of this accuracy are the calibration uncertainties which appear in the specification tables of Section 6.

Similarly, users cannot ever verify the instrument's traceable accuracy to closer limits than their own calibration uncertainties.

If an instrument were correctly calibrated against the factory standard at its uncertainty limit, and then verified against a user's standard, also at its limit; there are two extremes to the range of traceable results which could be obtained. If, for example, both standards' traceable errors were equal and in the same sense, the instrument would appear to verify as absolutely accurate. But if the errors were in opposite sense, it would appear to be inaccurate by the sum of the two limits of uncertainty.

In the following numerical example, a 1081 is verified in the factory at + 10V on the 10V DC Range, with 0ppm error, against a 3ppm-high standard. It remains correctly calibrated, and could be delivered to one of two users: one user's standard is 3ppm higher than the National Standard, and the other's is 3ppm lower.

The first user would verify the 1081 as having 0ppm error, but the second would obtain an error of + 6ppm; when in fact the instrument had sustained its original accuracy of + 3ppm, and all three standards were only 3ppm away from National Standards.

Therefore, on receipt of an instrument, its traceable accuracy specification cannot be verified exactly as may be assumed by reading the Section 6 accuracy tables only. An EXTRA tolerance must be added, equal to the factory calibration uncertainty (This appears in a separate column in Section 6 tables) PLUS the user's calibration uncertainty (Which the user will know). No closer verification tolerance can justifiably be imposed; so unless the instrument fails to verify within the extended figures, there is no confidence that it is outside its specification.

This increased uncertainty is unavoidable unless the same standard is used for each verification. This is clearly not a practical proposition following delivery. But after the first autocalibration against the user's standard, the factory uncertainty is eliminated.

Verification following User-calibration

Once an instrument has been Autocalibrated by a user, it discards the factory calibration uncertainty mentioned in the previous column. Its traceable accuracy can therefore be verified against the same standard used for calibration to a closer tolerance than it could on receipt, within the limits of that standard's calibration uncertainty.

In this case it is only necessary to add the USER'S calibration uncertainty to the figures in the accuracy tables of Section 6. Failure to verify within these reduced (but still extended) figures, gives confidence that it is outside its traceable accuracy specification.

Limit Calculations

a. On Receipt from Datron

Select the appropriate CALIBRATION INTERVAL and Input the value (V) at which the 1081 is to be verified. Obtain the calibration uncertainty of the standard to be used to verify the 1081, at this value.

Add the standard's uncertainty (Us ppm) to the 1081 'Spec' mode 90-day readout (Ur ppm) at this value.

Let the total be Ut (ppm):

$$Ut = Ur + Us \text{ (ppm)}.$$

Calculate the limits from:

$$\text{Positive Limit } (+\text{Lim}) = V + \frac{(V \times Ut)}{10^6}$$

$$\text{Negative Limit } (-\text{Lim}) = V - \frac{(V \times Ut)}{10^6}$$

b. Following User-calibration

Select the appropriate CALIBRATION INTERVAL and Input the value (V) at which the 1081 is to be verified. Obtain the calibration uncertainty of the standard to be used to verify the 1081, at this value.

Add the standard's uncertainty (Us ppm) to the 1081 'Spec' mode display readout (Ur ppm), then subtract Datron's calibration uncertainty (Ud ppm) at this value. Let the total be Ut (ppm):

$$Ut = Ur + Us - Ud \text{ (ppm)}$$

Calculate the limits from:

$$\text{Positive Limit } (+\text{Lim}) = V + \frac{(V \times Ut)}{10^6}$$

$$\text{Negative Limit } (-\text{Lim}) = V - \frac{(V \times Ut)}{10^6}$$

Verification Procedures

DC Performance

(Use Tables 1a and 1b of the Report Sheet)

1. Turn on the instrument to be checked and allow a minimum of 2 hours to warm up in the specified environment.
2. Ensure that all 'MODE' and 'COMPUTE' LEDs are unlit, set the Local/Remote Guard switch to 'Local Guard', and check that 'cal' is not displayed.
3. Select 'Test' and check that the instrument passes its Self Test criteria (See Section 3).
4. Connect the DC voltage source, with its output turned down to zero, between 'Hi' and 'Lo'. Allow the input to stabilize.

N.B. Operation 5 must also be carried out every time the Voltage Source range is changed.

5. Select 'DC', 'Auto', 'Filter' and 'Zero'. The instrument will carry out its Auto-zero routine, turning off the 'Zero' LED when complete.

NOTE: In operation 6; when checking the 0.1V and 1V Ranges, it will be necessary to turn the DC source down to zero and allow the thermal EMFs to disappear or stabilize (several minutes). Select range then 'Zero', to remove any offset. The signal may then be applied.

This procedure should be repeated if changing polarity involves reversal of leads, as the thermal EMFs may have changed.

6. Select each range in turn as listed on Table 1a of the Report Sheet. Apply the corresponding Full Range input value between 'Hi' and 'Lo'. Calculate the tolerance limits using 'Spec' mode for the value as described on page 7-2 (a or b), recording them on the table. Record the displayed reading and check that it is between the calculated limits.
7. Select the 10V Range. Apply the input values in turn between 'Hi' and 'Lo', as listed in Table 1b of the Report Sheet. Calculate the tolerance limits using 'Spec' mode for each value as described on page 7-2 (a or b), recording them on the table. Record the displayed reading and check that it is between the calculated limits.

AC Performance

(Use Tables 2a and 2b of the Report Sheet)

1. Carry out DC Performance checks 1 to 3 if the DC Performance has not been verified.
2. Select each range in turn as listed on Table 2a of the Report Sheet. Apply the corresponding Full Range input value, at the specified frequency, between 'Hi' and 'Lo'. Calculate the tolerance limits using 'Spec' mode for the value as described on page 7-2 (a or b), recording them on the table. Record the displayed reading and check that it is between the calculated limits.
7. Select the 10V Range. Apply the 200Hz input values in turn between 'Hi' and 'Lo', as listed in Table 2b of the Report Sheet. Calculate the tolerance limits using 'Spec' mode for each value as described on page 7-2 (a or b), recording them on the table. Record the displayed reading and check that it is between the calculated limits.

Resistance Performance

(Use Table 3 of the Report Sheet)

1. Carry out DC Performance checks 1 to 3 if the DC Performance has not been verified.
2. Connect a True 4-wire Zero as detailed in Section 2 'Resistance Measurement'. Select 'kΩ', 'Filter' and 'Zero'.

NOTE: For operation 3, True 4-wire connection is recommended throughout; but a 2-wire arrangement can be used for 1MΩ and above, in which case '2-wireΩ' should be selected. If high value standards are fitted with a 'Guard' terminal, this should be connected to 'Ω Guard'.

3. Select each range in turn as listed on Table 3 of the Report Sheet. On each range; carry out operation 2, then use the 1081 to measure the value of the corresponding standard Full Range resistor. Calculate the tolerance limits for the value using 'Spec' mode as described on page 7-2 (a or b), recording them on the table. Record the displayed reading and check that it is between the calculated limits.

Verification Report

Notes on the Use of the Report Sheet

1. **Tables**
   DC Voltage . . . . . page 7-5
   AC Voltage . . . . . page 7-6
   Resistance . . . . . page 7-6

2. **Duplicate copies**
   To generate copies of the Report Sheet for future use, it is recommended that pages 7-5 to 7-6 be used only as masters for duplication.

3. **'Zero' operation**
   The comparison between a DC Voltage or Resistance reading and its Calculated Tolerance Limits is valid only if the reading follows a 'Zero' operation.

4. **To Calculate Verification Tolerances on receipt from Datron:**
   Set the CALIBRATION INTERVAL switch at the rear of the 1081 to 90dy, and input the desired value (V) from a Calibration Standard. Select 'Spec' Mode and add the 90-day readout (Ur ppm) to the Standard's uncertainty (Us ppm) at this value. Let the total be Ut (ppm):

   $$\mathbf{Ut = Ur + Us\ (ppm)}$$

   (Convert % to ppm by: U (ppm) = $10^4 \times$ U (%))

   Calculate the limits from:

   $$\text{Negative Limit } (-\text{Lim}) = V - \frac{(V \times Ut)}{10^6}$$

   $$\text{Positive Limit } (+\text{Lim}) = V + \frac{(V \times Ut)}{10^6}$$

5. **To Calculate Verification Tolerances after User-calibration:**
   Set the switch at the rear of the 1081 to the appropriate CALIBRATION INTERVAL, and input the desired value (V) from a Calibration Standard. Select 'Spec' Mode and add the 1081 readout (Ur ppm) to the Standard's uncertainty (Us ppm) at this value, then subtract Datron's calibration uncertainty (Ud ppm – refer to the tables). Let the total be Ut (ppm):

   $$\mathbf{Ut = Ur + Us - Ud\ (ppm)}$$

   (Convert % to ppm by: U (ppm) = $10^4 \times$ U (%))

   Calculate the limits from:

   $$\text{Negative Limit } (-\text{Lim}) = V - \frac{(V \times Ut)}{10^6}$$

   $$\text{Positive Limit } (+\text{Lim}) = V + \frac{(V \times Ut)}{10^6}$$

Specification Verification Report Sheet

Datron Model ..... Serial Number ..... Calibration Interval ..... Stability/Accuracy

Date ..... Checked by ..... Company/Dept .....

1. DC Voltage

a) Full Range Checks following a 'Zero' operation on all ranges

Polarity /Range	DC Source Voltage	Spec Mode Readout (±Ur ppm)	Datron Uncert'y (±Ud ppm)	Cal. Std. Uncert'y (±Us ppm)	Calculated Tolerance Limits − Lim	+ Lim	READING
+ 100mV			5				
− 100mV			5				
+ 1V			3				
− 1V			3				
+ 10V			3				
− 10V			3				
+ 100V			5				
− 100V			5				
+ 1000V			5				
− 1000V			5				

b) 10V Range Linearity following a 'Zero' operation.

Polarity /Nominal Value	DC Source Voltage	Spec Mode Readout (±Ur ppm)	Datron Uncert'y (±Ud ppm)	Cal. Std. Uncert'y (±Us ppm)	Calculated Tolerance Limits − Lim	+ Lim	READING
+ 10mV			3				
− 10mV			3				
+ 100mV			3				
− 100mV			3				
+ 1V			3				
− 1V			3				
+ 10V			3				
− 10V			3				
+ 19V			3				
− 19V			3				

2. AC Voltage

a) Full Range Checks

Range	AC Source Voltage	Frequency	Spec Mode Readout (±Ur ppm)	Datron Uncert'y (±Ud ppm)	Cal. Std. Uncert'y (±Us ppm)	Calculated Tolerance Limits − Lim	Calculated Tolerance Limits + Lim	READING
100mv		200Hz		100				
		3kHz		100				
		30kHz		200				
1V		200Hz		50				
		3kHz		50				
		30kHz		100				
10V		200Hz		50				
		3kHz		50				
		30kHz		100				
100V		200Hz		50				
		3kHz		50				
		30kHz		100				
1000V	500.00V	200Hz		100				
	500.00V	3kHz		100				
	500.00V	30kHz		200				

b) 10V Range Linearity at 200Hz

Nominal Value	AC Source Voltage	Spec Mode Readout (±Ur ppm)	Datron Uncert'y (±Ud ppm)	Cal. Std. Uncert'y (±Us ppm)	Calculated Tolerance Limits − Lim	Calculated Tolerance Limits + Lim	READING
10mv			50				
100mV			50				
1V			50				
10V			50				
19V			50				

3. Resistance

Following a 'Zero' operation on all ranges.

Range	Sense 4 wire or 2 wire	Calibration Value	Spec Mode Readout (±Ur ppm)	Datron Uncert'y (±Ud ppm)	Cal. Std. Uncert'y (±Us ppm)	Calculated Tolerance Limits − Lim	Calculated Tolerance Limits + Lim	READING
100MΩ	2 or 4			20				
1000kΩ	2 or 4			15				
100kΩ	2 or 4			10				
10kΩ	4			5				
1kΩ	4			5				
0.1kΩ	4			5				
10Ω	4			5				

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